BIOLOGY

SINDH BOARD NOTES

10 TH CLASS

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Unit 10

Gaseous Exchange

Long Answer Questions

Q.1 What do you know about cellular respiration?

Ans. Cellular respiration is the process in which the C-H bonds in food are broken by oxidation reduction reactions and energy is transformed into ATP.

Q.2 What is aerobic respiration?

Ans. In aerobic respiration, oxygen is used and there is complete oxidation of the food material. Carbon dioxide and water are also produced in this process.

Q.3 Define gaseous exchange. Why oxygen is needed?

Ans. Definition

Taking in oxygen and giving out of carbon dioxide is termed as gaseous exchange.

Need of Oxygen

Organisms get the oxygen needed for cellular respiration from their environment and provide it to their cells. The carbon dioxide which produces during cellular respiration is taken out of the cells and ultimately from the body.

Q.4 What is breathing? How is it different from respiration?

Ans. Breathing

The process through which animals take air in their bodies to get oxygen from it and then give out the air for getting rid of carbon dioxide.

Difference between respiration and breathing

RESPIRATION	BREATHING
(i) It involves the mechanical and the bio-chemical processes. **(ii)** It is of two types and takes place in cells.	**(i)** It is only the mechanical or physical process of exchanging the gases. **(ii)** It occurs in two phases and takes place in respiratory system.

Q.5 Describe the process of gaseous exchange in plants.

Ans. Introduction

Plants have no organs or systems for the exchange of gases with the environment. Every cell of a plant exchanges gases with the environment by its own.

Explanation

i) Gaseous exchange in leaves and young stems

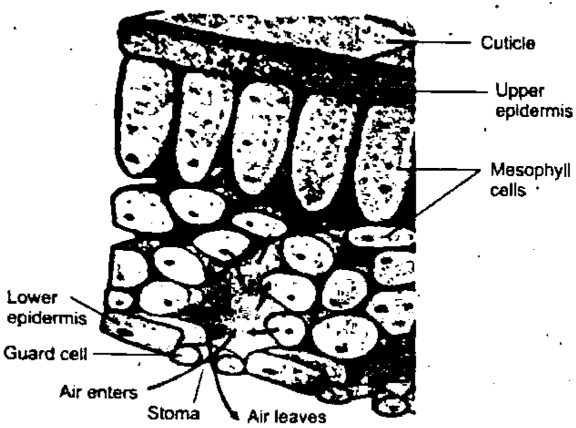
The leaves and young stems have stomata in their epidermis for gaseous exchange.

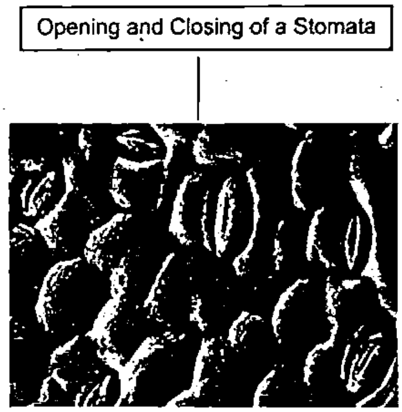
The inner cells of leaves (mesophyll) and stems also have air spaces among them which help in the exchange of gases. In young stems and leaves, some gaseous exchange also occurs through cuticle.

Explanation

During the daytime mesophyll cells of leaves carry out photosynthesis and respiration side by side, the oxygen produces in photosynthesis is utilized in cellular respiration. Similarly the carbon dioxide produces during cellular respiration is utilized in photosynthesis.

However, during night when there is no photosynthesis occurring, the leaf cells get oxygen from the environment and release carbon dioxide through stomata.





ii. Gaseous exchange in woody stems and mature roots

In woody stems and mature roots, the entire surface is covered by bark which is impervious to gases or water. However, there are certain pores in the layer of bark. These are called the lenticels. The lenticels allow air to pass through them.

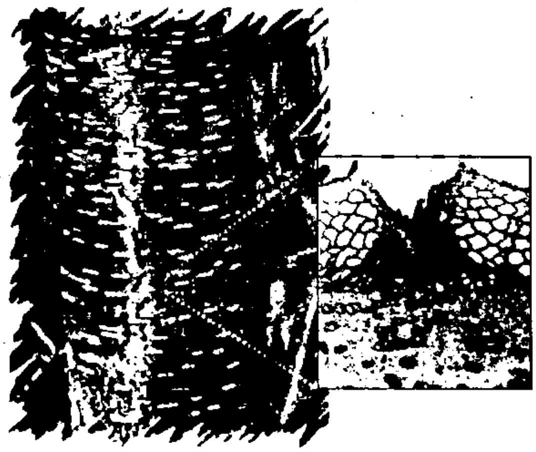


Figure 10.2: Lenticels on a stem and the internal view of a lenticel

iii. Gaseous exchange in young roots

Gases are found in the soil surrounding the roots. These gases diffuse in and out of the general surface of the young roots.

iv. Gaseous exchange in aquatic plants

The aquatic plants get the oxygen dissolved in water and release carbon dioxide in the water.

Q.6 Describe the structure and functions of human respiratory system.

Ans. Introduction

In humans and other higher animals, the exchange of gases is carried out by the respiratory system.

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اللہ تبارک تعالیٰ ہم سب کا حامی و ناصر ہو

Parts of respiratory system

We can divide respiratory system in two parts i.e.

(1) The air passageway

(2) The lungs

1. Air passageway

Definition

It consists of the parts through which the outside air comes in the lungs and after the exchange of gases it goes out.

Parts of air passageway

This passage of air consists of the following parts:

a) Nasal cavity and nostrils

The nose encloses the nasal cavity. It opens to the outside through the openings called the nostrils.

Structure

The nasal cavity is divided into two portions by a wall. Each portion is lined by fine hairs and mucous.

Function

Fine hairs and mucous filter the dust particles from the air. The mucous also moistens and warms the incoming air and keeps its temperature nearly equal to that of the body.

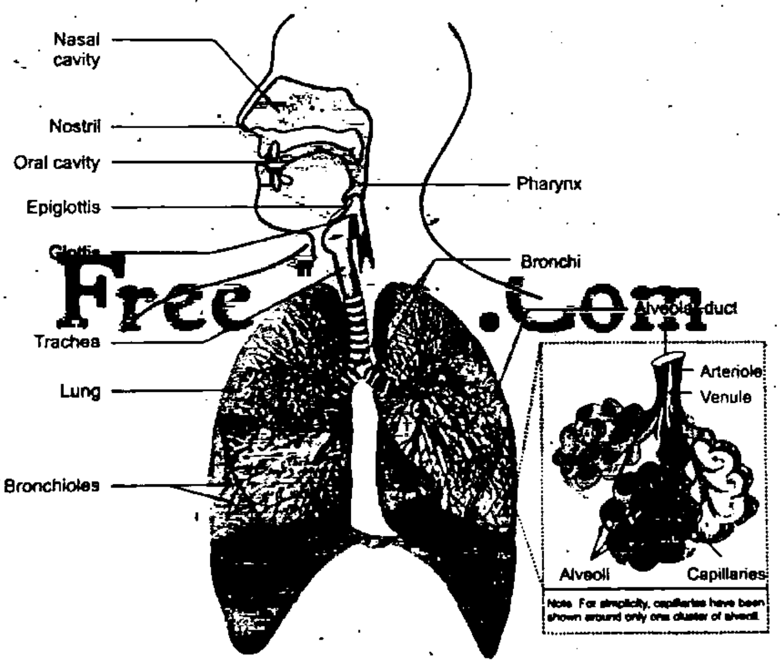


Figure 10.3: The air passageway and the lungs

b) Pharynx

The nasal cavity opens into the pharynx by means of two small openings called internal nostrils. It is a muscular passage and is common to both food and air. It extends to the opening of the oesophagus and the larynx.

c) Glottis and epiglottis

It is a narrow opening at the floor of pharynx which leads into larynx. The air goes from the pharynx into the larynx. The glottis is guarded by a flap of tissue called the epiglottis.

d) Larynx or voice box

The larynx is a box made of cartilage. It is also called the voice box.

Location

It is present between pharynx and trachea.

Vocal cords and sound production

Two pairs of fibrous bands called vocal cords are stretched across the larynx. When the air passes through them, the vocal cords vibrate. This vibration produces sounds. Movements of lips, cheeks, tongue and jaws produce specific sounds which results in speech. Speech is an ability of only humans.

e) Trachea

Larynx continues to the trachea, which is also called the windpipe.

Length and location

It is about 12 cm long tube which lies in front of the oesophagus.

Structure

There are C-shaped cartilagenous rings in the wall of trachea.

Function of cartilage

The cartilages keep the trachea from collapsing even when there is no air in it.

f) Bronchi

On entering the chest cavity, the trachea divides into two smaller tubes called bronchi (singular: bronchus).

Structure

The bronchi also have cartilagenous plates in their walls.

Division of Bronchi

Each bronchus enters into the lung of its side and then divides into smaller branches.

Other functions of trachea and bronchi

Both trachea and the bronchi are also lined with ciliated and glandular cells.

Function of glandular cells

These cells secrete mucous which moistens the air and also traps any fine particles of dust or bacteria that have escaped from the nasal cavity.

Function of cilia

The cilia beat with an upward motion so that the foreign particles along the mucous are sent to the oral cavity from where it may be either swallowed or coughed out.

g) Bronchioles

The bronchi continue dividing in the lungs until they make several fine tubes called bronchioles. The bronchioles progressively lose the cartilages as they become narrower.

h) Alveolar Ducts

The bronchioles end as fine tubules called the alveolar ducts.

i) Alveoli

Each alveolar duct opens into a cluster of pouches called alveoli.

Structure

Each alveolus is a sac-like structure lined by a single layer of epithelial cells. It is bound on the outside by a network of capillaries.

j) Pulmonary artery

The pulmonary artery from the heart containing deoxygenated blood enters the lungs and branches into arterioles and then into capillaries which surround the alveoli.

k) Pulmonary vein

Capillaries join together to form the venules which form pulmonary vein. The pulmonary vein carries the oxygenated blood back to the heart.

2) Lungs

All the alveoli on one side constitute a lung. There is a pair of lungs in the thoracic cavity.

Chest wall formation

It is made up of 12 pairs of ribs and the rib muscles called intercoastal muscles.

Diaphragm

A thick muscular structure present below the lungs is called diaphragm.

Lobes of lungs

The left lung is slightly smaller and has two lobes and the right lung is bigger with three lobes. They are spongy and elastic organs.

Blood vessels of lungs

The lungs also have blood vessels that are the branches of the pulmonary arteries and veins.

Pleural membranes

Each lung is enclosed by two membranes called the outer pleural membrane and the inner pleural membrane.

The membranes enclose a fluid which provides lubrication for the free expanding and contracting of the lungs.

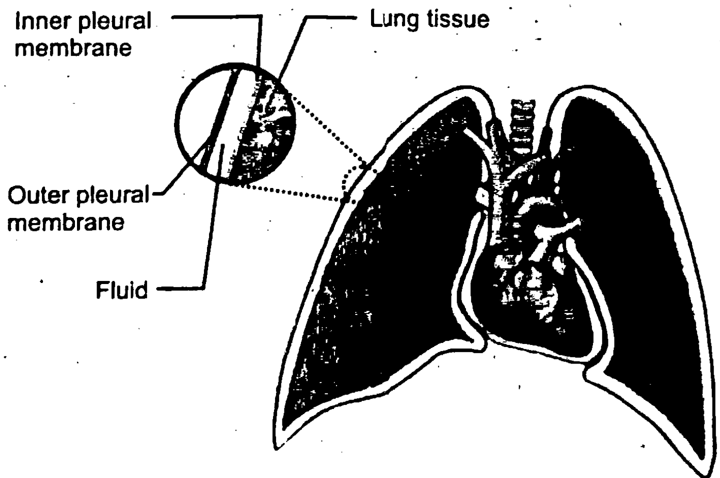


Figure 10.4: Lungs and pleural membranes

Q.7 Describe the mechanism of breathing. (Board 2014)

Ans. Introduction

The physical movements associated with the gaseous exchange are called breathing.

Phases of Breathing

There are two phases of breathing i.e.

1. Inhalation
2. Exhalation

1. Inhalation or inspiration

a) Contraction of rib muscles and diaphragm

During inspiration the rib muscles contract and ribs are raised. At the same time the dome shaped diaphragm contracts and is lowered.

b) Effect of contraction

These movements increase the area of the thoracic cavity which reduces the pressure on lungs. As a result, the lungs expand and the air pressure within them also decreases. The air from outside rushes into the lungs to equalize the pressure on both sides.

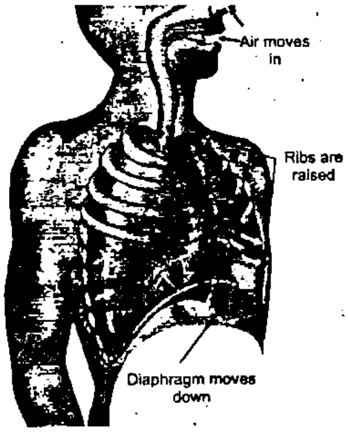


Figure 10.5: Steps of Inhalation

2. Exhalation or expiration

a) Relaxation of rib muscles and diaphragm

After the gaseous exchange in the lungs, the impure air is expelled out in exhalation. The rib muscles relax bringing the ribs back to the original position. The diaphragm muscles also relax and it gets its raised dome shape.

b) Effect of relaxation

This reduces the space in the chest cavity and increases the pressure on lungs. The lungs contract and the air is expelled out of them.

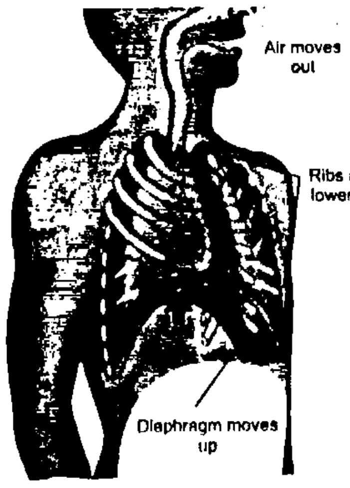


Figure 10.6: Steps of Exhalation

Breathing rate of humans

Humans breathe 16 – 20 times per minute in normal circumstances i.e. at rest.

Control of Breathing rate

The rate of breathing is controlled by the respiratory centre in the brain. The respiratory centre is sensitive to the concentration of carbon dioxide in the blood. When we do exercise or some hard job, our muscle cells carry out cellular respiration at greater rate. It results in the production of more carbon dioxide which is released in the blood. This greater than normal concentration of carbon dioxide stimulates the respiratory centre of brain. The respiratory centre sends messages to the rib muscles and diaphragm to increase the rate of breathing so that the excess carbon dioxide present in blood can be removed out of body.

Breathing rate during exercise

During exercise or other hard physical works the breathing rate may increase up to 30–40 times per minute.

Q.8 Describe the comparison between the inspired and the expired air.

Ans.

Feature	Inspired air	Expired air
Amount of oxygen	21%	16%
Amount of carbon dioxide	0.04%	4%
Amount of nitrogen	79%	79%
Amount of water vapours	Variable	Saturated
Amount of dust particles	Variable	Almost none
Temperature	Variable	Almost equal to body temperature

Q.9 Describe different types of respiratory disorders in man.

Ans. There are a number of respiratory disorders which affect people. The high percentage of respiratory disorders in Pakistan is due to more concentration of air pollutants both in urban and rural atmosphere.

Some of the important respiratory disorders are:

i. Bronchitis

a) Introduction

It is the inflammation of the bronchi or bronchioles.

b) Causes

i) It results in excessive secretion of mucous into the tubes, leading to the swelling of tubular walls and narrowing of tubes.

ii) It is caused by viruses, bacteria or exposure to chemical irritants (e.g. tobacco smoke).



Figure 10.7: Bronchi normal (left) and inflamed (right)

c) **Types**

There are two major types of bronchitis i.e. acute and chronic.

i) **Acute Bronchitis**

It usually lasts about two weeks and patient recovers with no permanent damage to bronchi or bronchioles.

ii) **Chronic bronchitis**

In chronic bronchitis, the bronchi develop chronic inflammation. It usually lasts for three months to two years.

d) **Symptoms**

Symptoms of bronchitis include:

Cough
Mild wheezing
Fever
Chills
Shortness of breath (especially when doing hard job)

e) **Age limit**

The majority of people diagnosed with chronic bronchitis are 45 years of age or older.

ii. Emphysema

Introduction

It is the destruction of the walls of the alveoli.

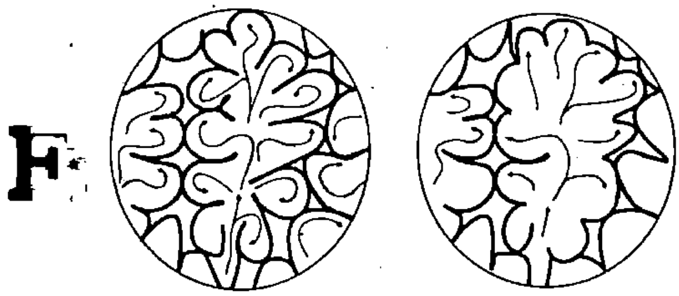


Figure 10.8: The Alveoli, normal (left) and emphysema (right)

Explanation

It results in larger sacs but with less surface area for gaseous exchange. As lung tissue breaks down, the lungs do not come back to their original shape after exhalation so air cannot be pushed out and is trapped in the lungs.

Symptoms

It includes:

i. Shortness of breath
ii. Fatigue
iii. Recurrent respiratory infections.
iv. Weight loss

By the time the symptoms of emphysema appear, the patient has usually lost 50% to 70% of his/her lung tissue.

Effects

The level of oxygen in blood may get so low that it causes serious complications.

iii. Pneumonia

Introduction

It is an infection of lungs.

Double pneumonia

If this infection affects both lungs, it is called double pneumonia.

Causes

The most common cause of pneumonia is a bacterium, *Streptococcus pneumoniae.* Some viral (influenza virus) and fungal infections may also lead to pneumonia.

Explanation

When the causative organisms enter the alveoli, they break the lung tissues and the area is filled with fluid and pus.

Symptoms

It includes a cold that is followed by a high fever, shivering, and a cough with sputum production. Patient may become short of breath.

Effects

The patient's skin colour may change and become dusky or purplish. It is due to poor oxygenation of blood.

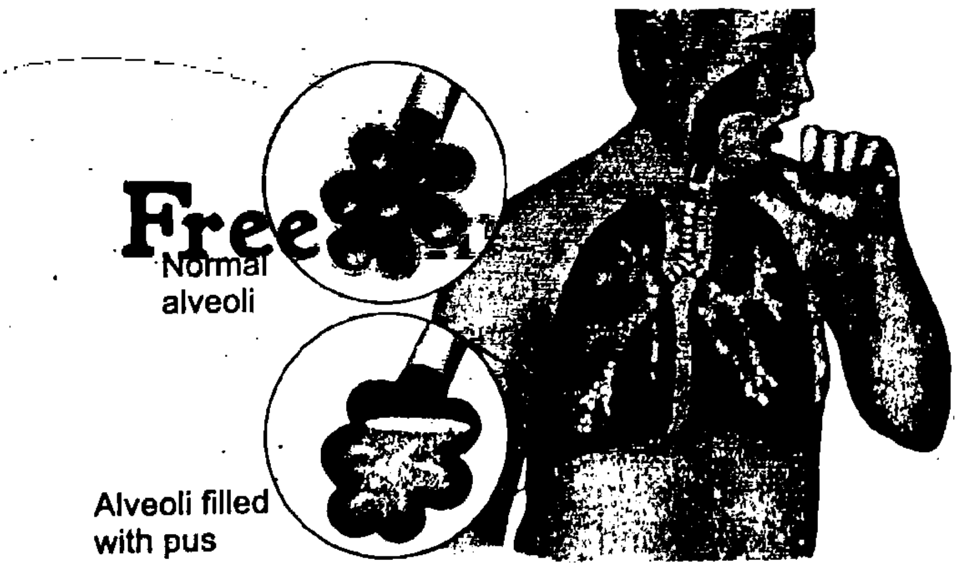


Figure 10.9: Pneumonia

Treatment

i. Vaccines are available to prevent pneumonia caused by *S. pneumoniae.*

ii. Antibiotics are used in the treatment of this disease.

iv. Asthma

Introduction

It is a form of allergy, in which there is inflammation of the bronchi, more mucous productio and narrowing of the airways.

Explanation

In asthma patients, the bronchi and bronchioles become sensitive to different allergens (allergy causing factors) e.g. dust, smoke, perfumes, pollens etc. When exposed to any of such allergens, the sensitive airways show immediate and excessive response of constriction. In this condition, the patient feels difficulty in breathing.

Symptoms

It varies from person to person. It includes:

i. Shortness of breath (especially with exertion or at night)
ii. Wheezing (whistling sound when breathing out)
iii. Cough
iv. Chest tightness

Treatment

The medicine in the form of inhalers with ability to dilate the bronchi and bronchioles are used in the treatment of asthma.

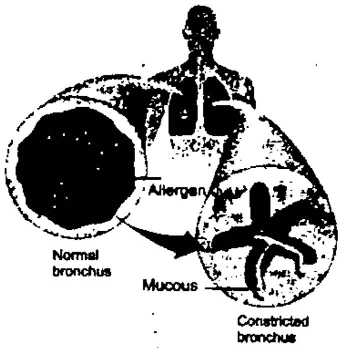


Figure 10.10: Asthma

(v) Lung Cancer / Explain lung cancer and Passive smoking (Board 2014)

Introduction

It is a disease of uncontrolled cell divisions in the tissues of the lung.

Explanation

In lung cancer, cells continue to divide without any control and form tumours. The cellular growth may also invade adjacent tissues beyond the lungs.

Symptoms

The most common symptoms are:

i. Shortness of breath
ii. Coughing (including coughing up blood)
iii. Weight loss

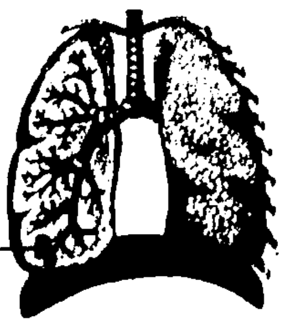


Figure 10.11: Lung Cancer

Causes

(1) Main cause:

Smoking is the main cause of lung cancer.

(2) Other Causes are:

(i) Carcinogens (such as those in cigarette smoke)

(ii) Ionizing radiation

(iii) Viral infection

Known number of carcinogens

Cigarette smoke contains over 50 known carcinogens.

Lung cancer in non- smokers

The risk of lung cancer is significantly lower in non-smokers.

Passive smoking (the inhalation of smoke from another's smoking) is also a cause of lung cancer. The smoke from the burning end of a cigarette is more dangerous than the smoke from the filter end.

Prevention

(i) Eliminating tobacco smoking is a primary goal in the prevention of lung cancer.

(ii) The World Health Organization has called for governments to stop tobacco advertising to prevent young people from taking up smoking.

(iii) If a person stops smoking the chance to develop cancer decreases as damage to the lungs is repaired and contaminant particles are gradually removed.

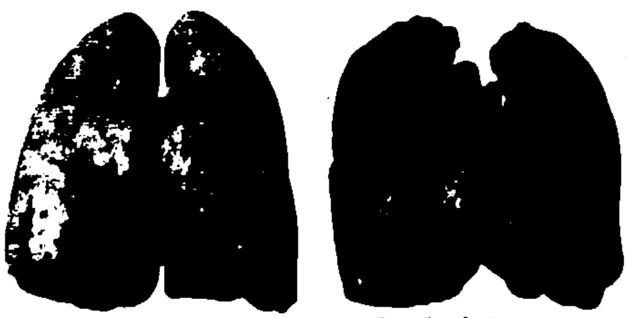
Effects

Lung cancer is the most common cause of cancer-related deaths and is responsible for more than 1.3 million deaths worldwide annually.

Q.10 Describe bad effects of smoking. Or Write two bad effects of smoking (Board 2014)

Ans. Introduction

Smoking is harmful due to the chemicals in cigarettes and smoke.



Normal Lungs Smoker's Lungs

Number of chemicals in cigarette smoke

Tobacco smoke contains over 4000 different chemicals, out of which at least 50 are carcinogens and many are poisonous.

Diseases due to smoking

Smoking not only produces lung cancer but also produces a number of life threatening diseases like:

(a) Cancers in

(i) Kidneys
(ii) Oral cavity
(iii) Larynx
(iv) Breast
(v) Bladder
(vi) Pancreas etc.

(b) Emphysema and other respiratory disorders

Many chemicals in tobacco smoke damage the air passageway, which leads to emphysema and other respiratory disorders.

Other effects of smoking

(a) Reduction in the oxygen carrying capacity

It has effects on the circulatory system. The carbon monoxide present in tobacco smoke lessens the oxygen carrying capacity of haemoglobin.

(b) Increase in the production of platelets

Many other chemicals in smoke increase the production of blood platelets. When platelets are more than the normal numbers, they make the blood viscous and it can lead to arteriosclerosis.

(c) Risk of tuberculosis and pneumonia

Smokers are at greater risk of developing infections, particularly in the lungs like risk of tuberculosis increases by two to four times, and of pneumonia by four times.

(d) Weakening and staining the teeth

Smoking is responsible for weakening and staining the teeth. Tooth loss is 2 to 3 times higher in smokers than in non-smokers.

(e) Effect on social life

Smoking also affects the social life of a person. Smokers may face social unacceptance because other people may not want to be exposed to other's smoke.

(f) Increase in the rate of heart diseases and cancer in non- smokers

Non-smokers who are exposed to second-hand smoke at home or work increase their heart disease risk by 25-30 and their lung cancer risk by 20-30%.

Q11. What do you know about Nicotine?

Ans. Nicotine is a powerful poison and was widely used as an insecticide in the past. When inhaled through tobacco smoking, it reaches our circulatory system and not only hardens the walls of the arteries but also damages the brain tissues.

Q12. When the "World No Tobacco Day" is celebrated?

Ans. It is celebrated on the 31st of May every year.

Unit 11

Homoeostasis

Long Answer Questions

Q.1 Define homeostasis. Why body of an organism needs this? Which processes help in its occurrence?

Ans. Homeostasis may be defined as the maintenance of the internal conditions of body at equilibrium, despite changes in the external environment.

Examples:

1. The core temperature of human body remains at about 37°C despite fluctuations in the surrounding temperature.
2. The blood glucose level remains about 1g per liter despite eating a meal rich in carbohydrates.

Need of homeostasis:

An organism's body needs homeostasis because:

1. Body cells need the internal environment in which conditions do not change much.
2. Stable internal conditions are important for the efficient functioning of enzymes.

Processes helping in homeostasis

1. Osmoregulation

Definition

It is maintenance of the amounts of water and salts in body fluids (i.e. blood and tissue fluids).

Effect of osmoregulation

Relative amount of water and salts in body fluids and inside cells control the processes of diffusion and osmosis, which are essential for the functioning of cells.

2. Thermoregulation

Definition

The maintenance of internal body temperature is called thermoregulation.

Effect of thermoregulation

The enzymes of body work best at particular temperatures (optimum temperature). Any change in body temperature may affect the functioning of enzymes.

3. Excretion

Definition

Excretion is also a process of homeostasis. In this process, the metabolic wastes are eliminated from body to maintain the internal conditions at equilibrium.

Metabolic wastes

Metabolic waste means any material that is produced during body metabolism and that may harm the body.

Q.2 Describe homeostasis in plants. What different mechanisms are adopted for homeostasis in plants? OR How plants remove metabolic wastes? **(Board 2014)**

Ans. Homeostasis in plants

Plants respond to environmental changes and keep their internal conditions constant i.e. homeostasis. They apply different mechanisms for the homeostasis of water and other chemicals (oxygen, carbon dioxide, nitrogenous materials etc).

Removal of extra Carbon dioxide

In daytime, the carbon dioxide produced during cellular respiration is utilized in photosynthesis and hence it is not a waste product. At night, it is surplus because there is no utilization of carbon dioxide. It is removed from the tissue cells by diffusion. In leaves and young stems, carbon dioxide escapes out through stomata. In young roots, carbon dioxide diffuses through the general root surface, especially through root hairs.

Removal of extra oxygen

Oxygen is produced in mesophyll cells only during daytime, as a by-product of photosynthesis. After its utilization in cellular respiration the mesophyll cells remove the extra amount of oxygen through stomata.

Removal of extra water

1. Transpiration

(a) Definition

Transpiration is the loss of water from plants surface in the form of vapours e.g; conifers and most of plants.

(b) Explanation

Plants obtain water from soil and it is also produced in the body during cellular respiration. Plants store large amount of water in their cells for turgidity. Extra water is removed from plant body by transpiration.

At night, transpiration usually does not occur because most plants have their stomata closed. If there is a high water content in soil, water enters the roots and is accumulated in xylem vessels.

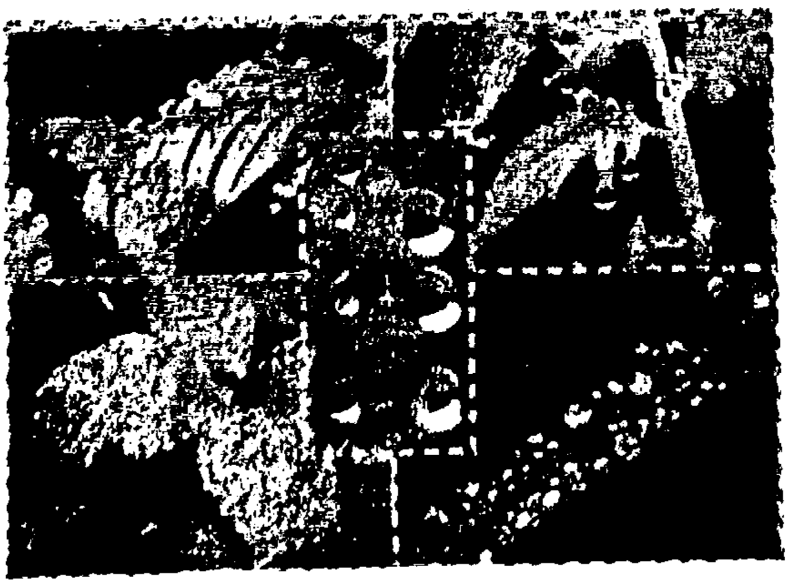


Figure 11.1: Guttation in different plants

2. Guttation

(a) Definition

The appearance of drops of water on the tips or edges of leaves is called guttation. Guttation is not to be confused with dew, which condenses from the atmosphere on to the plant surface.

(b) Explanation

Some plants such as grasses and strawberry force this water through special pores, present at leaf tips or edges, and form drops.

Removal of Other Metabolic Wastes

Plants deposit many metabolic wastes in their bodies as harmless insoluble materials.

Example

1. Calcium oxalate crystals

Calcium oxalate is deposited in the form of crystals in the leaves and stems of many plants e.g. in tomato.



Figure11.2: Calcium oxalate needles in a leaf cell

2. Shedding of leaves

In trees, which shed their leaves yearly, the excretory products are removed from body during leaf fall.

3. Resins

Resins are removed by coniferous trees.

4. Gums

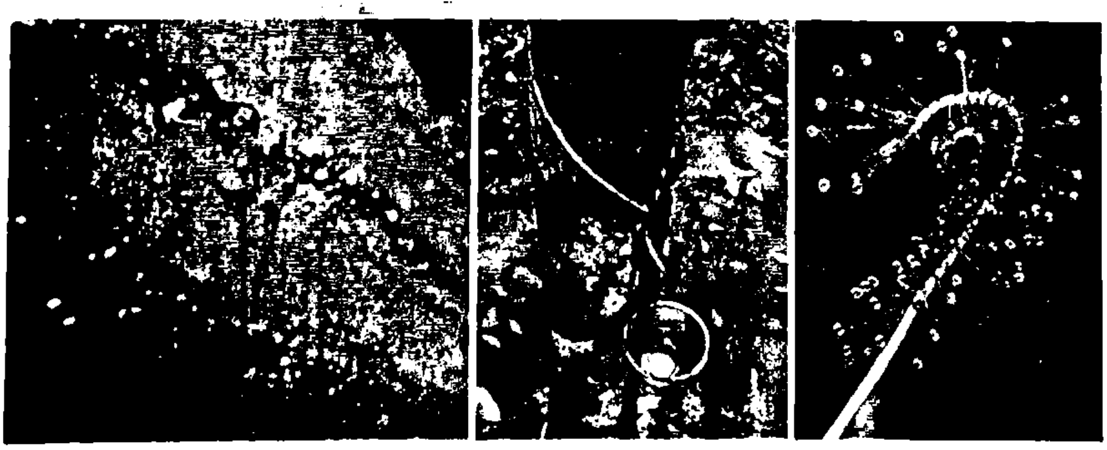
Gums are removed by keekar.

5. Latex

Latex are removed by rubber plants.

6. Mucilage

Mucilage are removed by carnivorous plants and lady finger.



Resin drops from a cut tree | Latex being extracted from a tree | Mucilage drops on a carnivorous plant

Figure11.3: Removal of some wastes in plants

Q.3 Describe osmotic adjustments in plants. OR On the basis of the available amount of water and salts, plants can be divided in how many groups? Explain.

Ans. On the basis of the available amount of water and salts, plants are divided into three groups.

1. Hydrophytes **2. Xerophytes** **3. Halophytes**

1. Hydrophytes

Definition

Hydrophytes are the plants which live completely or partially submerged in freshwater. Such plants do not face the problem of water shortage.

Adaptations

They have developed mechanisms for the removal of extra water from their cells.

Large number of Stomata

Hydrophytes have broad leaves with a large number of stomata on their upper surfaces. This characteristic helps them to remove the extra amount of water.

Examples

The most common example of such plants is water lilly.

2. Xerophytes

Definition

These plants live in dry environments.

Adaptations

i. Cuticle

They possess thick, waxy cuticle over their epidermis to reduce water loss from internal tissues.

ii. Less Stomata

They have less number of stomata to reduce the rate of transpiration.

iii. Deep roots

Such plants have deep roots to absorb maximum water from soil.

iv. Special Parenchyma cells

Some xerophytes have special parenchyma cells in stem or roots in which they store large quantities of water. This makes their stems or roots wet and juicy, called **succulent organs**.

Examples

Cacti (singular *cactus*) are common examples.

3. Halophytes

Definition

These plants live in sea water and are adapted to salty environments. Salts enter in the bodies of such plants due to their higher concentration in sea water. On the other hand, water tends to move out of their cells into the hypertonic sea water.

Adaptations

Holding of large amount of Salts

When salts enter into cells, plants carry out active transport to move and hold large amount of salts in vacuoles. Salts are not allowed to move out through the semi-permeable membranes of vacuoles. So the sap of vacuoles remains even more hypertonic than sea water. In this way, water does not move out of cells.



Hydrophytes Halophytes Xerophytes

Figure 11.4: three groups of plants

Examples

Many sea grasses are included in this group of plant.

Q4. What are the organs of humans which work for homeostasis? Describe skin and lungs in detail.

Ans. Humans have highly developed systems for homeostasis. The following are the main organs which work for homeostasis:

1. Lungs

They remove excess carbon dioxide and keep it in balance.

2. Skin

Skin performs role in maintenance of body temperature and also removes excess water and salts.

3. Kidneys

They filter excess water, salts, urea, uric acid etc. from the blood and form urine.

Explanation

Skin / What is skin? Write its function. **(Board 2014)**

a. Structure of skin

Our skin consists of two layers:

1. Epidermis is the outer protective layer without blood vessels.
2. Dermis is the inner layer containing blood vessels, sensory nerve endings, sweat and oil glands, hairs and fat cells.

b. Roles of Skin

i. Regulation of body Temperature

Thin layer of fat cells in the dermis insulates the body. Contraction of small muscles attached to hair forms **'Goosebumps'**. It creates an insulating blanket of warm air.



Figure11.5: Goosebumps

ii. Cooling effect

Skin helps in providing cooling effect when sweat is produced by sweat glands and excess body heat escapes through evaporation. Metabolic wastes such as excess water, salts, urea and uric acid are also removed in sweat.

Lungs

i. Removal of carbon dioxide

Lungs maintain the concentration of carbon dioxide in blood. During cellular respiration our cells produce carbon dioxide. From cells, this carbon dioxide diffuses into tissue fluid and from there into blood. Blood carries carbon dioxide to lungs from where it is removed in air.

Q5. Describe urinary system of humans. Also describe the structure of nephron?

Ans. Urinary system of Humans

The excretory system of humans is also called the urinary system. It is formed of one pair of kidneys, a pair of ureters, a urinary bladder and a urethra.

Kidneys

Kidneys filter blood to produce urine.

Ureters

The ureters carry urine from kidneys to urinary bladder.

Bladder

The bladder temporarily stores urine until it is released from body.

Urethra

Urethra is the tube that carries urine from urinary bladder to the outside of body.



Figure11.6: The Urinary system of humans

Structure of kidney

(i) Colour and shape

Kidneys are dark-red bean shaped organs.

(ii) Size

Each kidney is 10 cm long, 5cm wide and 4 cm thick.

(iii) Weight

Each kidney weighs about 27 grams.

(iv) Location

They are placed against the back wall of abdominal cavity just below diaphragm, one on either side of vertebral column. They are protected by the last 2 ribs. The left kidney is a little higher than the right.

(v) Hilus

The concave side of kidney faces vertebral column. There is a depression, called hilus, near the centre of the concave area of kidney. This is the area of kidney through which ureter leaves kidney and other structures including blood vessels, lymphatic vessels and nerves enter and leave kidney.

(vi) Renal cortex

The longitudinal section of kidney shows two regions. Renal cortex is the outer part of kidney and it is dark in colour.

(vii) Renal medulla

Renal medulla is the inner part of kidney and is pale red in colour.

(viii) Pyramids

Renal medulla consists of several cone-shaped areas called renal pyramids.

(ix) Renal pelvis

Renal pyramids project into a funnel – shaped cavity called renal pelvis, which is the base of ureter.

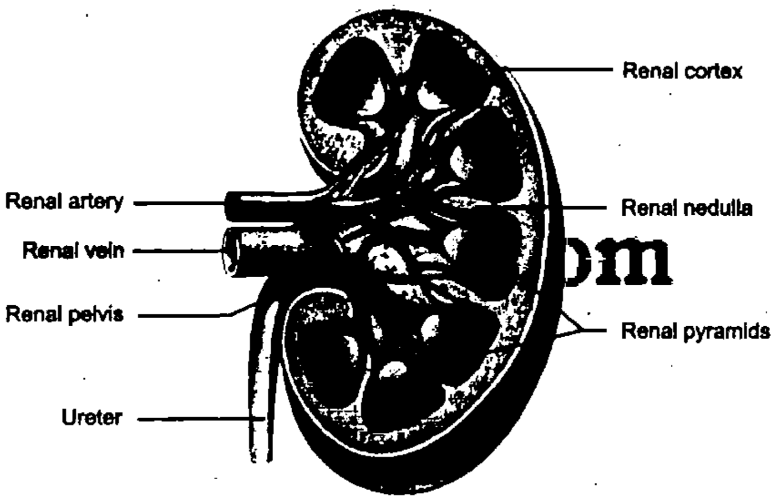


Figure11.7: The anatomy of a kidney

Draw the labeled diagram of human kidney (Board 2014)

Structure of nephron **(Board 2013)**

The functional unit of the kidney is called nephron. There are over one million nephrons in each kidney.

Parts of Nephron

There are two parts of a nephron:

1. Renal corpuscle
2. Renal tubule

1. Renal corpuscle

The renal corpuscle is not tubular and has two parts:

(i) Glomerulus

It is a network of capillaries.

(ii) Bowman's capsule

Bowman's capsule is a cup-shaped structure that encloses glomerulus.

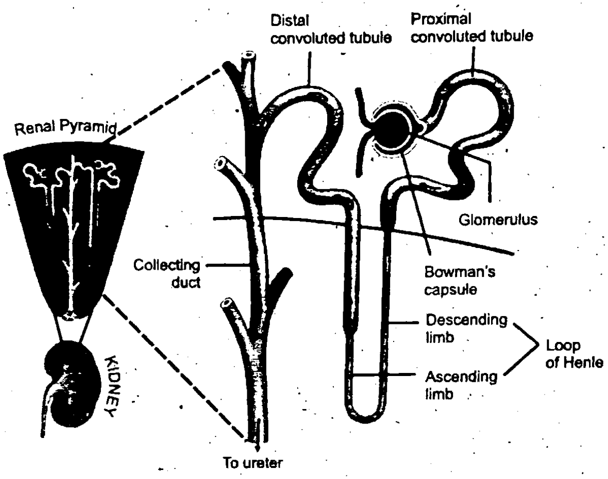


Figure11.8: The structure of a nephron

2. Renal tubule

Renal tubule is the part of nephron which starts after Bowman's capsule. It is sub - divided into following parts:

(i) Proximal convoluted tubule.

First portion of renal tubule is called proximal convoluted tubule.

(ii) Loop of Henle

Next portion is U- shaped and is called the loop of Henle.

(iii) Distal convoluted tubule

The last portion of renal tubule is the distal convoluted tubule.

(iv) Collecting ducts and Papillary ducts

The distal convoluted tubule of many nephrons open in a single collecting duct. Many collecting ducts join together to form several hundred papillary ducts which drain into renal pelvis.

Q.6 Write a note on functioning of kidney.

Functioning of kidney:

Ans. The main function of kidney is urine formation which takes place in three steps:

i. Pressure filtration **ii.** Selective re-absorption **iii.** Tubular secretion

i.Pressure filtration

The first step is pressure filtration. When blood enters the kidney via the renal artery, it goes to many arterioles, and then to the glomerulus. The pressure of blood is very high and so most of the water, salts, glucose and urea of blood is forced out of glomerular capillaries. This material passes into the Bowman's capsule and is now called glomerular filtrate.

ii. Selective re-absorption

The second step is the selective re-absorption. In this step about 99% of the glomerular filtrate is reabsorbed into the blood capillaries surrounding renal tubule. It occurs through osmosis, diffusion and active transport. Some water and most of the glucose is reabsorbed from the proximal

convoluted tubule. Here, salts are reabsorbed by active transport and then water follows by osmosis. The descending limb of Loop of Henle allows the reabsorption of water while the ascending limb of Loop of Henle allows the reabsorption of salts. The distal convoluted tubule again allows the reabsorption of water into the blood.

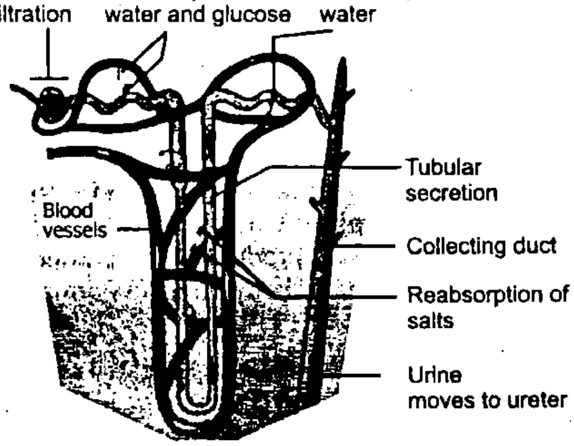


Figure11.9: Functioning of kidney (Nephron)

iii. Tubular secretion

The third step is the tubular secretion. Different ions, creatinine, urea etc. are secreted from blood into the filtrate in renal tubule. This is done to maintain blood at a normal pH (7.35-7.45) after the above mentioned steps, the filtrate present in renal tubules is known as urine. It moves into collecting ducts and then into pelvis.

Q.7 Write the normal composition of urine.

Ans. The normal composition of urine is shown in the following table:

Table 11.1 Normal Chemical composition of urine (source: NASA Contractor Report)

Water	95%
Urea	9.3g/l
Chloride ions	1.87g/l
Sodium ions	1.17g/l
Potassium ions	0.750 g/l
Other ions and compounds	Variable amounts

Q.8 Describe osmoregulatory function of kidney.

Ans. Osmoregulation

Osmoregulation is defined as the regulation of the concentration of water and salts in blood and other body fluids. Kidneys play an important role in osmoregulation by regulating the water contents of blood. It is an important process as excessive loss of water concentrates the body fluids whereas excess intake of water dilutes them.

Dilute urine

When there is excess water in body fluids, kidneys form dilute (hypotonic) urine. For this purpose, kidneys filter more water from glomerular capillaries into Bowman's capsule. Similarly less water is reabsorbed and abundant dilute urine is produced. It brings down the volume of body fluids to normal.

Concentrated urine

When there is shortage of water in body fluids, kidneys filter less water from glomerular capillaries and the rate of reabsorption of water is increased. Less filtration and more reabsorption produce small amount of concentrated (hypertonic) urine. It increases the volume of body fluids to normal. This whole process is under hormonal control.

Q.9 What do you know about Kidney disorders?

Ans. There are many different kidney disorders:

(i) Kidney stones

When urine becomes concentrated, crystals of many salts e.g. calcium oxalate, calcium and ammonium phosphate, uric acid etc are formed in it. Such large crystals cannot pass in urine and form hard deposits called kidney stones. Most stones start in kidneys, some may travel to ureter or urinary bladder.

Causes of Kidney stones

Major causes of kidney stones are:

1. Age
2. Diet (containing more green vegetables, salts, vitamins C and D)
3. Recurring urinary tract infections
4. Less intake of water
5. Alcohol consumption

Symptoms of kidney stones

Following are the symptoms of kidney stones:

1. Severe pain in kidney or in lower abdomen
2. Vomiting
3. Frequent urination
4. Foul- smelling urine with blood and pus

Treatment of kidney stones

(i) Drinking plenty of water

About 90% of kidney stones can pass through the urinary system by drinking plenty of water.

(ii) Surgical treatment

In surgical treatment, the affected area is opened and stone (s) are removed

(iii) Lithotripsy

Lithotripsy is another method for the removal of kidney stones. In this method, non-electrical shock waves from outside are bombarded on the stones in the urinary system. Waves hit the dense stones and break them. Stones become sand-like and are passed through urine.

(ii) Kidney (Renal) Failure

Kidney failure means a complete or partial failure of kidneys to function.

Causes of kidney failure

Following are causes of kidney failure:

i. Diabetes mellitus
ii. Hypertension
iii. Sudden interruption in the blood supply to kidneys
iv. Drug overdoses

Symptoms of kidney failure

Main symptoms include:

i. High level of urea and other wastes in blood
ii. Vomiting
iii. Nausea
iv. Weight loss
v. Frequent urination
vi. Blood in urine
vii. Excess fluids in body may causes swelling of legs, feet and face
viii. Shortness of breath

Treatment of kidney Failure

Kidney failure is treated with:
i. Dialysis
ii. Kidney transplant

1. Dialysis **(Board 2013)**

Dialysis means the cleaning of blood by artificial ways. There are two methods of dialysis:
(1) Peritoneal Dialysis
(2) Haemodialysis

(1)Peritoneal Dialysis

In this type of dialysis, the dialysis fluid is pumped for a time into the peritoneal cavity which is the space around gut. This cavity is lined by peritoneum. Peritoneum contains blood vessels. When we place dialysis fluid in peritoneal cavity, waste materials from peritoneal blood vessels diffuse into the dialysis fluid, which is then drained out. This type of dialysis can be performed at home, but must be done every day.

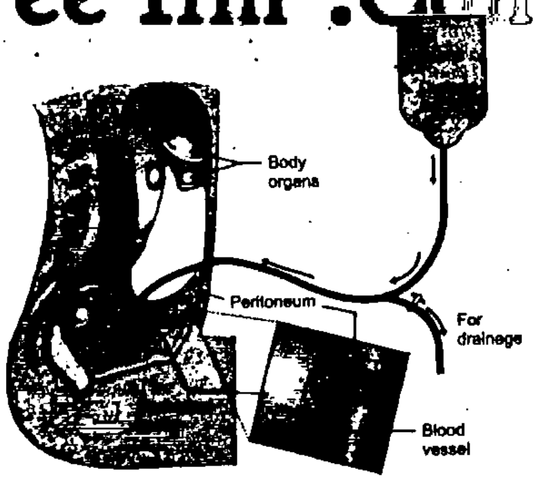


Figure11.10: Peritoneal dialysis

(2)Haemodialysis

In haemodialysis, patient's blood is pumped through an apparatus called dialyzer. The dialyzer contains long tubes, the walls of which act as semi-permeable membranes. Blood flows through the tubes while the dialysis fluid flows around the tubes. Extra water and wastes move from blood into

the dialysis fluid. The cleansed blood is then returned back to body. The haemodialysis treatments are typically given in dialysis centres three times per week.

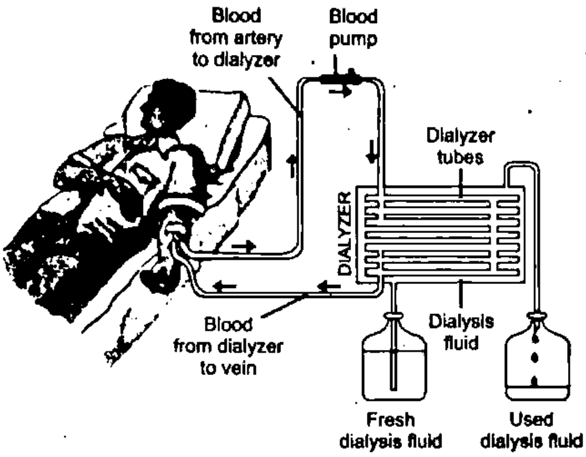


Figure11.11: Haemodialysis

ii) Kidney Transplant

Introduction

Dialysis needs to be repeated after every few days and is unpleasant for patients and attendants. Another treatment for the end-stage kidney failure is kidney transplantation. It is the replacement of patient's damaged kidney with a donor healthy kidney.

Conditions for Transplant

(1) Kidney may be donated by a deceased-donor or living donor.

(2) The donor may or may not be a relative of the patient.

(3) Before transplant, the tissue proteins of donor and patient are matched.

(4) The donor's kidney is transplanted in patient's body and is connected to the patient's blood and urinary system.

(5) The average lifetime for a donated kidney is 10 to 15 years.

(6) When transplant fails, the patient may be given a second kidney transplant. In this situation, the patient is treated through dialysis for some intermediary time.

Problems after transplant

Problems after a transplant may include transplant rejection, infections, imbalances in body salts which can lead to bone problems and ulcers.

Q.10 What are the contributions of Muslim scientists about kidney diseases?

Ans. Contributions of Abu Nasr al-Farabi

Abu Nasr al-Farabi (872-951) was a prominent scientist who wrote many books that contained information about kidney diseases.

Contributions of Al-Zahrawi in removing stones

The genius Abu al Qasim Al-Zahrawi (known as Albucasis 936-1013) is considered to be Islam's greatest surgeon who invented many surgical procedures including the surgical removal of stones from the urinary bladder. His encyclopedia, Al-Tasrif ("The Method") contained over 200 surgical medical instruments he personally designed.

Unit 12

Coordination and Control

Long Answer Questions

Q.1 What do you mean by coordination? Explain its mechanism with examples.

Ans. Coordination

Definition

The coordination is developed when body works as one unit, in which its different organs and systems cooperate and work in harmony with each other.

Explanation

The tissues and organs in the bodies of multicellular organisms do not work independent of each other. They work together performing their many tasks as the needs of the whole body. This means that these activities are coordinated. The process is called coordination. Coordination also enables the organism to respond to happenings in the world around it.

Example No. 1

One familiar example of coordination is the way in which muscles work together during movement. When a boy runs to catch a ball, he uses hundred of muscles to move his arms, legs and back. His nervous system uses information from his sense organs and coordinates these muscles. Due to this coordination, the muscles contract in the correct sequence, power, and length of time. But that is not all. Such activities involve many other kinds of coordination. For example, breathing and heartbeat rates are increased, blood pressure is adjusted, and extra heat is removed fast from the body.



Example No. 2

When we are writing something, our hands and fingers work in collaboration with our muscles, eyes, thoughts etc. and then very intricate movements result.

Q.2 Name the types of coordination. Explain the components of a coordinated action in detail.

Ans. TYPES OF COORDINATION:

There are two types of coordination in organisms:

(i) Nervous coordination

It is brought about by nervous system.

(ii) Chemical coordination

It is brought about by endocrine system.

Animals have both the nervous and chemical coordination systems in their bodies while **plants** and other organisms have only chemical coordination.

Components of coordinated action

A coordinated action has five components.

i. Stimuli

Definition

A stimulus is defined as any change in environment (external and internal), which can provoke a response in organism.

Examples

Examples of stimuli are heat, cold, pressure, sound waves, presence of chemicals, microbial infections etc.

ii. Receptors

Definition

The organs, tissues or cells which are specifically built to detect particular type of stimuli are called receptors.

Examples

Sound waves are detected by ears, light is detected by eyes, chemicals in air are detected by nose.

iii. Coordinators

Definition

These are the organs that receive information from receptors and send messages to particular organs for proper action.

Examples

(i) In nervous coordination, brain and spinal cord are coordinators. They receive information and send messages through neurons in the form of nerve impulses.

(ii) On the other hand, in chemical coordination, various endocrine glands play the role of coordinators. They receive information in the form of various chemicals and send messages by secreting particular hormones in blood.

iv. Effectors

Definition

These are the parts of body which receive messages from coordinators and produce particular responses.

Examples

(i) In nervous coördination, neurons carry messages from coordinators (brain and spinal cord) to muscles and glands, which act as effectors.

(ii) In chemical coordination, particular hormones carry messages from coordinators, (endocrine glands) to particular target tissues, which act as effectors. For some hormones, nephrons act as effectors. Similarly, bones and liver act as effectors for many hormones.

v. Response.

Definition

On receiving the message from coördinators, the effectors perform action. This action is called response. Usually, nervous coordination produces immediate but short living responses while chemical coordination produces slow but long living responses.

Example- Pulling our hand away from something very hot.

The movement of the flower of sunflower towards light are the examples of responses.

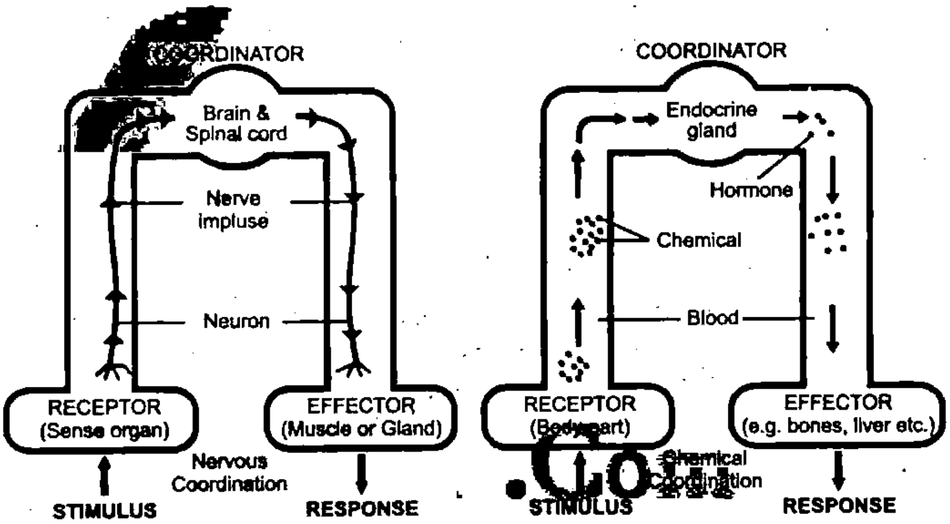


Figure 12.1: Neurons and chemical coordination

Q.3 (a) What do you know about human nervous system?

(b) Explain neuron in detail

Ans. (a) Human Nervous system

The nervous system in man and in other higher animals is composed of two major components.

(1) Central Nervous System (C.N.S)

A system which comprises of brain and spinal cord is called central nervous system.

(2) Peripheral Nervous System (P.N.S)

Peripheral nervous system (P.N.S) consists of nerves that arise from central nervous system and spread in different parts of body.

All these components of human nervous system are made of neurons.

(b) Neuron or Nerve cell

Introduction

Nerve cell or neuron is the unit of nervous system. All the components of human nervous system are made of neurons.

Human Nervous system

The human nervous system consists of billions of neurons plus supporting (neuroglial) cells.

Function of Neurons

Neurons are specialized cells that are able to conduct nerve impulses from receptors to co-ordinators and from coordinators to effectors. In this way, they communicate with each other and with other types of body cells.

Nerve impulse

A nerve impulse is a wave of electrochemical changes that travels along the length of neuron.

Structure of neuron

Neuron consists of:

(a) Cell body

The nucleus and most of the cytoplasm of a neuron is located in its cell body.

(b) Dendrites and axon

Different processes extend out from the cell body. These are called dendrites and axon

(c) Direction of nerve impulses:

Dendrites conduct impulses towards the cell body and axons conduct impulses away from the cell body.

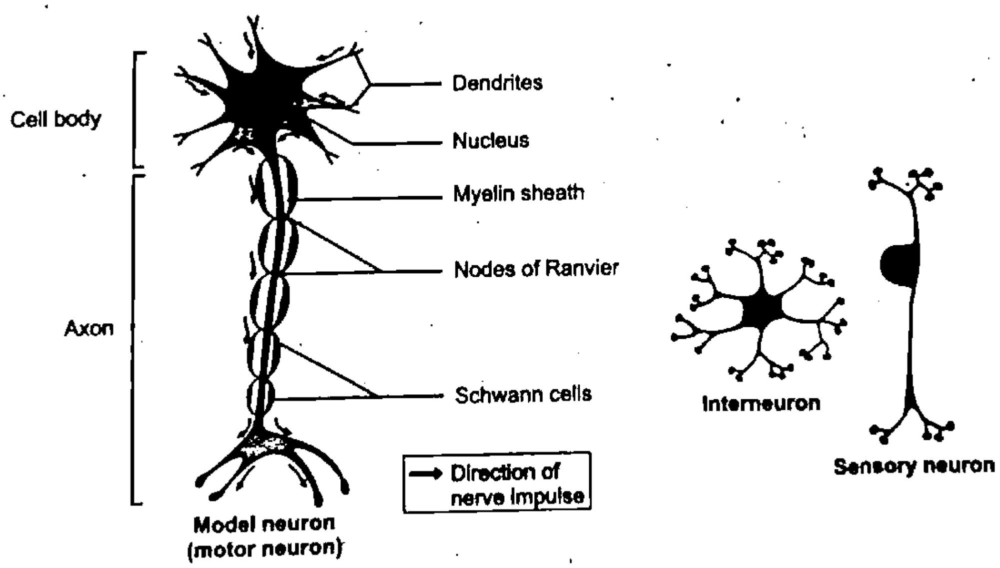


Figure 12.2: Neurons

(d) Schwann Cells

Schwann cells are special neuroglial cells located at regular intervals along axons.

(e) Myelin Sheath

In some neurons, Schwann cells secrete a fatty layer called myelin sheath and it is located over axon. Myelin sheath is an insulator so the membrane coated with this sheath does not conduct nerve impulse. In such a neuron, impulses "jump" over the areas of myelin sheath going from node to node. Such impulses are called **saltatory** (jumping) impulses.

Function of Saltatory Impulses:

This increases the speed of nerve impulses.

(f) Nodes of Ranvier

Between the areas of myelin on an axon, there are non-myelinated points called the nodes of Ranvier.

Types of Neuron

On the basis of their functions, neurons are of three types:

(a) Sensory neurons conduct sensory information (nerve impulse) from receptors towards the CNS. Sensory neurons have one dendrite and one axon.

(b) Interneurons form brain and spinal cord. They receive information, interpret them and stimulate motor neurons. They have many dendrites and axons.

(c) Motor neurons carry information from interneurons to muscles or glands (effectors). They have many dendrites but only one axon.

Q.4 Define nerve. Explain its types. **(Board 2014)**

Ans. Nerve

A nerve means the union of several axons that are enveloped by a covering made of lipid.

Types of nerves

Based on the property of axons, the nerves are classified into three types:

1. **Sensory nerves**

   They contain the axons of sensory neurons only.

2. **Motor nerves**

   They contain the axons of motor neurons only.

3. **Mixed nerves**

   They contain the axons of both i.e. sensory and motor neurons.

Q.5 Explain Central Nervous System (C.N.S) in detail.

Ans. Parts of CNS

CNS consists of two parts:

(i) Brain **(ii) Spinal cord**

(i) **Brain**

Introduction

In animals, all life activities are under the control of brain. The structure of brain is suitable to perform this function.

Location

Brain is situated inside a bony cranium i.e. a part of skull.

Meninges

Inside cranium, brain is covered by three layers called meninges.

Function of meninges

Meninges protect brain and also provide nutrients and oxygen to brain tissues through their capillaries.

Ventricles

The brain contains fluid filled ventricles that are continuous with the central canal of spinal cord.

Cerebrospinal fluid (CSF)

Fluid within ventricles and central canal is called cerebrospinal fluid (CSF).

Function of CSF

It provides cushioning and ions to brain and spinal cord.

Division of Brain

There are three main regions in the brain of humans and other vertebrates. These are forebrain, midbrain, and hindbrain.

(a) Forebrain **(Board 2013)**

Introduction

Forebrain is the largest area of brain. It is most highly developed in humans.

Parts of Forebrain

(i) Thalamus

Location

It lies just below the cerebrum.

Functions

It serves as a relay centre between various parts of brain and spinal cord. It also receives and modifies sensory impulses (except from nose) before they travel to cerebrum.
Thalamus is also involved in pain perception and consciousness i.e. sleep and awakening.

(ii) Hypothalamus

Location

It lies above midbrain and just below thalamus.

Size

In humans, it is about the size of an almond.

Function

(a) The most important function of hypothalamus is to link nervous system and endocrine system.

(b) It controls the secretions of pituitary gland.

(c) It controls feelings such as rage, pain, pleasure and sorrow.

(iii) Cerebrum

It is the largest part of forebrain.

Function

It controls skeletal muscles, thinking, intelligence and emotions.

Cerebral hemispheres

Cerebrum is divided into two cerebral hemispheres.

Olfactory Bulbs

The anterior parts of cerebral hemispheres are called olfactory bulbs which receive impulses from olfactory nerves and create the sensation of smell.

Cerebral cortex

The upper layer of cerebral hemisphere i.e. cerebral cortex consists of grey matter.

Grey matter

The grey matter of nervous system consists of cell bodies and non-myelinated axons.

White matter

Beneath this layer is present the white matter. The white matter of nervous system consists of myelinated axons. Cerebral cortex has a large surface area and is folded in order to fit in skull.

Lobes of cerebral cortex

It is divided into four lobes:

Lobe	Functions
Frontal	Controls motor functions, permits conscious control of skeletal muscles and coordinates movements involved in speech
Parietal	Contains sensory areas that receive impulses from skin
Occipital	Receives and analyzes visual information
Temporal	Concerned with hearing and smell

Hippocampus

It is a structure that is deep in the cerebrum. It functions for the formation of new memories. People with a damaged hippocampus cannot remember things that occurred after that but can remember things that occurred before damage.

(b) MIDBRAIN

Location:

Midbrain lies between hindbrain and forebrain and it connects the two.

Functions:

1. It receives sensory information and sends it to the appropriate parts of fore brain.
2. Midbrain also controls some auditory reflexes and posture.

(c) HINDBRAIN / What are parts of hind brain and how they perform their function?

Parts of hindbrain **(Board 2014)**

Hindbrain consists of three major parts:

1. Medulla Oblongata

Location

It lies on the top of spinal cord.

Functions

(i) It controls breathing, heart rate and blood pressure.
(ii) It also controls many reflexes such as vomiting, coughing, sneezing etc.

Information that passes between spinal cord and the rest of brain pass through medulla.

2. Cerebellum

Location

It is behind the medulla oblongata.

Function

It coordinates muscle movements.

3. Pons

Location

It is present on the top of medulla oblongata.

Function

(i) It assists medulla in controlling breathing.
(ii) It also serves as a connection between cerebellum and spinal cord.

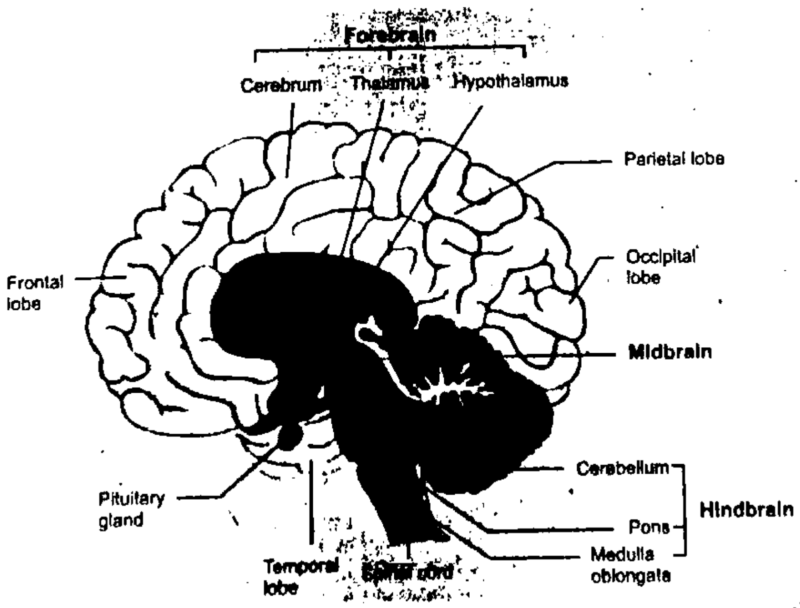


Figure 12.3: Structure of human brain

(ii) SPINAL CORD

Definition

It is a continuation of medulla oblongata.

Location

It starts from brain stem and extends to lower back.

STRUCTURE

The spinal cord is infact a tubular bundle of nerves. It is the continuation of medulla oblongata.

Length

It is roughly 40 cm long.

Width

It is about as wide as our thumb for most of its length.

Meninges

Like brain, spinal cord is also covered by meninges.

Protection of spinal cord

The vertebral column surrounds and protects spinal cord.

Outer Region

The outer region of spinal cord is made of white matter containing myelinated axons.

Central Region

The central region is butterfly-shaped that surrounds the central canal.

Composition

It is made of grey matter containing neuron cell bodies.

SPINAL NERVES

31 pairs of spinal nerves arise along spinal cord. These are "mixed" nerves because each contains axons of both sensory and motor neurons.

ROOTS OF SPINAL NERVES

At the point where a spinal nerve arises from spinal cord, there are two roots of spinal nerves. Both roots unite and form one mixed spinal nerve.

Dorsal root

The dorsal root contains sensory axons and a ganglion where cell bodies are located.

Ventral root

The ventral root contains axons of motor neurons.

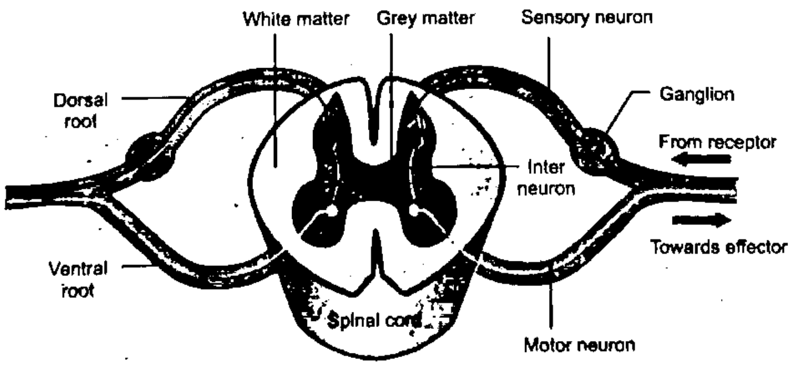


Figure 12.4: Spinal Cord and Spinal Nerves

Functions of Spinal Cord

1. It serves as link between body parts and brain. Spinal cord transmits nerve impulses from body parts to brain and from brain to the body parts.
2. Spinal cord also acts as a coordinator, responsible for some simple reflexes.

Q.6 Explain Peripheral Nervous System (PNS) in detail.

Ans. PERIPHERAL NERVOUS SYSTEM (PNS)

Components of PNS:

The PNS is composed of nerves and ganglia.

Ganglia

Ganglia are the clusters of neuron cell bodies outside the nervous system.

Number of cranial and spinal nerves.

Humans have 12 pairs of cranial nerves and 31 pairs of spinal nerves.

Types of nerves

Some cranial nerves are sensory, some are motor and some are mixed .
On the other hand, all spinal nerves are mixed nerves.

Pathways in PNS formed by Nerves

The cranial and spinal nerves make two pathways:
Sensory pathway which conducts impulses from receptors to CNS.
Motor pathway which conducts impulses from CNS to effectors.

Systems of Motor pathway:

Motor Pathway makes two systems:

1. **Somatic Nervous system**

It is responsible for the conscious and voluntary actions. It includes all of the motor neurons that conduct impulses from CNS to skeletal muscles.

2. **Autonomic Nervous System**

It is responsible for the activities, which are not under conscious control. It consists of motor neurons that send impulses to cardiac muscles, smooth muscle and glands.

Types of autonomic Nervous system

Autonomic nervous system comprises of sympathetic system and parasympathetic system.

(i) Sympathetic nervous system

This system prepares body to deal with emergency situations. This is often called the fight or flight responses. During an emergency situation, this system takes necessary actions. For example; it dilates pupils, accelerates heartbeat, increases breathing rate and inhibits digestion.

(ii) Parasympathetic nervous system

When stress ends, the **parasympathetic nervous system** takes action and normalizes all the functions. It causes pupil to contract, promotes digestion, and slows the rate of heartbeat and breathing rate.

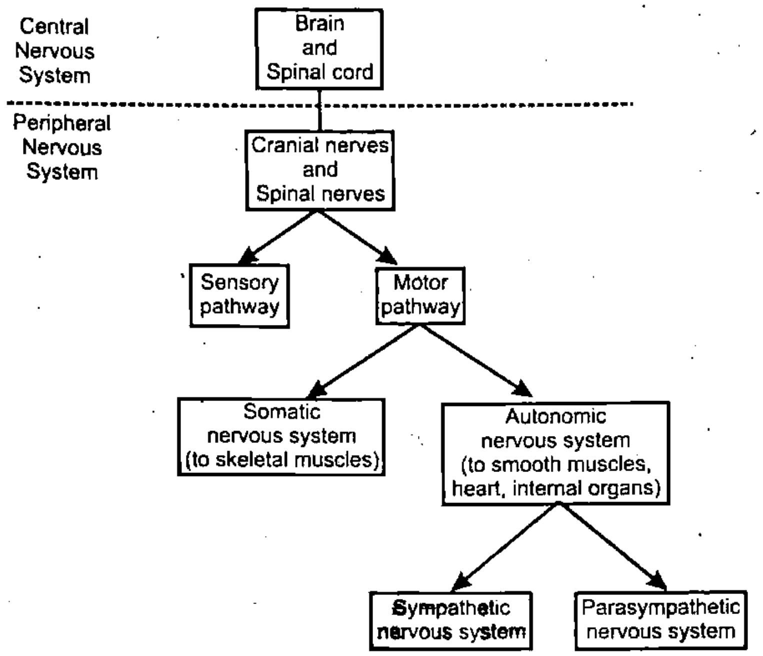


Figure 12.5: Division of the nervous system

Q.7 Define reflex action. Explain it with an example

Ans. REFLEX ACTION

Definition

Sometimes the involuntary response produced by the CNS is very quick. Such a response is called reflex action.

Types of action

When CNS sends impulses to muscles and glands, two types of actions or responses result.

Voluntary Actions

The higher centers of brain control the conscious action or voluntary actions.

Or

The actions which are done by our will are called voluntary actions.

Examples

Picking of book from the table, to take meal three times a day etc.

Involuntary Actions

Definition

When impulses are not passed to the higher centres of brain, it results in responses which are not under conscious control. Such responses are called involuntary actions.

Or

The actions which are not done by our will are called involuntary actions.

Examples

Heart beat, blood pressure etc.

Reflex arc

The pathway followed by the nerve impulses for producing a reflex action is called reflex arc.

Example of Reflex Action

The most common example of reflex action is the withdrawal of hand after touching a hot object.

Explanation

In this reflex action, spinal cord acts as coordinator. Heat stimulates temperature and pain receptors in skin. A nerve impulse is generated which is carried by sensory neurons to the interneurons of spinal cord.

From interneurons, the impulse is passed to the motor neurons which carry it to the muscles of the arm. As a result, the muscles contract to withdraw hand. During it, other interneurons transmit nerve impulses up to brain so that the person becomes aware of pain and what happened.

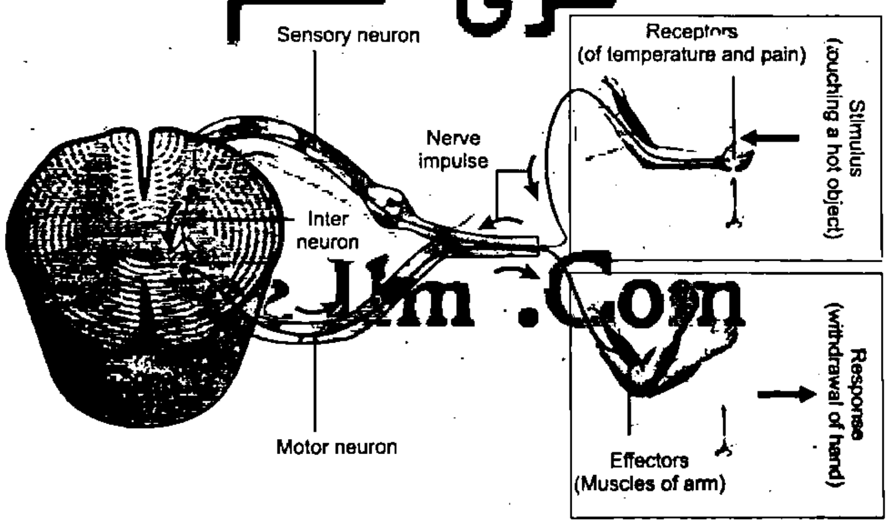


Figure 12.6: Reflex Arc in Reflex Action

Q.8 Describe structure and mechanism of function of human eye.

Ans. Human Eye

Location

Our eyes are located in small portions of skull known as the orbits or eye sockets.

External Structure of Eye

(i) Eyelids

Functions

Eyelids wipe eyes and prevent dehydration.

They spread tears on eyes which contain substances for fighting bacterial infections.

(ii) Eyelashes

Function

Eyelashes prevent fine particles from entering eye.

Internal structure of eye

The internal structure of eye can be divided into three main layers;

(i) Outer layer

The outer layer of eyeball consists of sclera and cornea.

(a) Sclera

It consists of dense connective tissue.

Functions

Sclera gives eye most of its white colour.

It protects the inner components of eye.

It maintains the shape of eye.

(b) Cornea

In the front, sclera forms the transparent cornea.

Function

Cornea admits light to the interior of eye and bends light rays so that they can be brought to a focus.

(ii) Middle Layer Choroid

The middle layer is called choroid.

Structure

It contains blood vessels.

Function

It gives the inner eye a dark colour. The dark colour prevents disruptive reflections within eye.

IRIS

Behind cornea, choroid bends to form a muscular ring called iris.

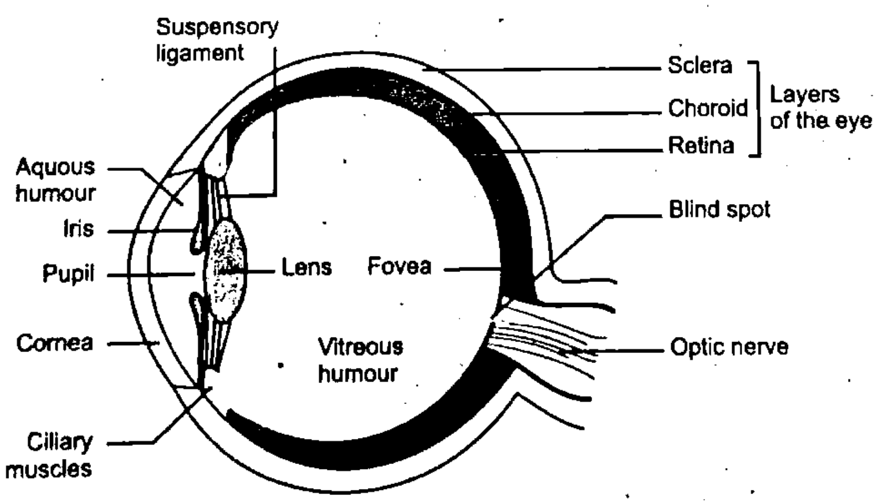


Figure 12.7: Structure of human eye

Pupil

There is a round hole, called pupil, in the centre of iris. After striking the cornea, light passes through the pupil.

Size

The size of pupil is adjusted by the muscles of iris.

Function

Pupil constricts in bright light when the circular muscles of iris contract Pupil dilates in dim light when the radial muscles of iris contract.

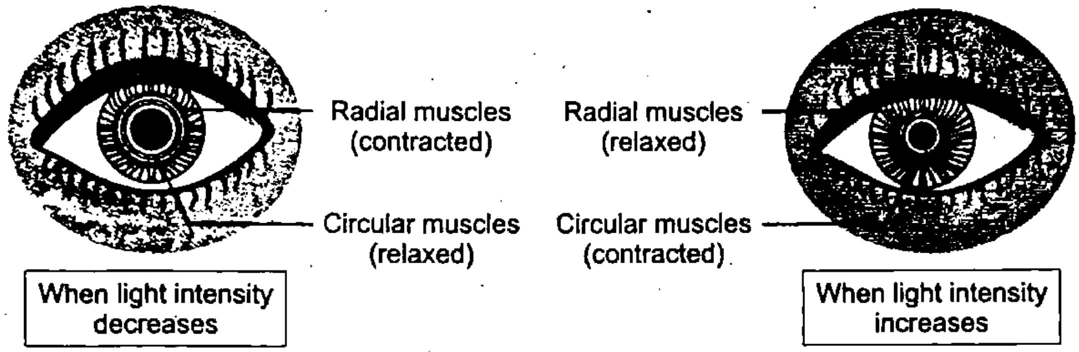


Figure 12.8: Contraction and dilation of pupil

Lens

Behind iris, there is a convex lens.

Function

It focuses light on the retina.

Ciliary muscles and Suspensory Ligaments

Lens is attached to ciliary muscles of eye via/through a ring of suspensory ligament.

Function

To see an object far clearly that is away, ciliary muscles are relaxed and lens becomes less convex. When ciliary muscles contract, lens becomes more convex and round.

(iii)INNER LAYER-RETINA

The inner layer is sensory and is called retina. It contains the photosensitive cells called rods and cones and associated neurons.

Rods

These are sensitive to dim light.

Cones

These are sensitive to bright light and they distinguish different colours.

Points on Retina

Retina has two points, fovea and optic disc.

Fovea

Fovea is a dip in retina directly opposite to lens and is densely packed with cone cells.

Function

It is largely responsible for colour vision and sharpness.

OPTIC DISC

Optic disc is a point on retina where the optic nerve enters retina.

Blind spot

There are no rods and cones at this point, that is why it is also referred to as the blind spot.

Chambers

The iris divides the cavity of eye into two chambers.

Anterior chamber

The anterior chamber is in front of iris i.e. between cornea and iris.

Aqueous humour

The anterior chamber contains a clear fluid known as aqueous humour.

Posterior chamber

The posterior chamber is between iris and retina.

VITREOUS HUMOUR

The posterior chamber contains a jelly – like fluid known as vitreous humour.

Function

It helps to maintain the shape of eye and suspends the delicate lens.

MECHANISM OF VISION

Light from objects enters eye and is refracted when it passes through cornea, aqueous humour, lens and vitreous humour. Lens also focuses light on retina. As a result, the image falls on retina. Rods and cones generate nerve impulses in the optic nerve. These impulses are carried to the brain, which makes the sensation of the vision.

Q.9 Explain the disorders of Eye. **(Board 2013-14)**

Ans. Following are the disorders of eye.

1. Night Blindness

Rods contain a pigment called rhodopsin. When light falls on rhodopsin, it breaks for generating a nerve impulse. In the absence of light, the breakdown products are again converted into rhodopsin. Body synthesizes rhodopsin from vitamin A and that is why the deficiency of vitamin A causes poor night vision. This problem is called night blindness.

2. Colour Blindness

Cones contain a pigment known as iodopsin. There are three main types of cones and each type has a specific iodopsin. Each type of cone recognizes one of the three primary colours i.e. blue, green and red. If any type of the cones is not working well, it becomes difficult to recognize that colour. Such person is not able to distinguish different colours. This disease is called colour blindness and is a genetic problem.

3. Myopia (Short sightedness)

The elongation of eyeball results in myopia. Such persons are not able to see distant objects clearly. The image of a distant object is formed in front of retina.

Cure

This problem can be rectified by using concave lens.

4. Hypermetropia (Long sightedness)

It happens when eyeball shortens. Such persons are not able to see near objects clearly. The image is formed behind retina.

Cure

Convex lens is used to rectify this problem.

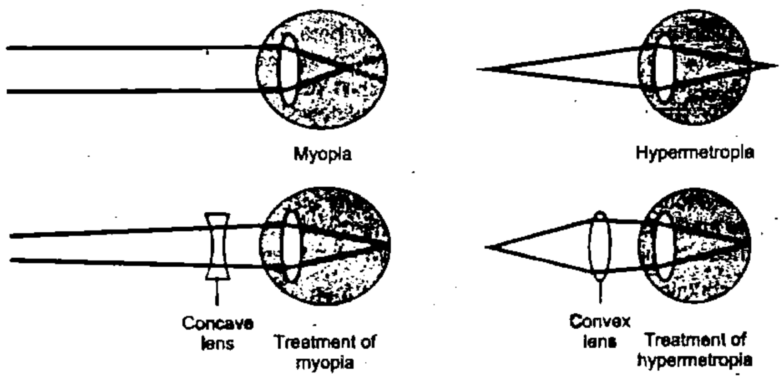


Figure 12.9: Myopia and Hypermetropia

Q.10 What is the contribution of Muslim scientists in the discovery and cure of eye diseases?

Ans. Ali ibn Isa (950-1012) was a famous Arab scientist. He wrote three books on ophthalmology (study of the diseases and surgery of eyes). He described 130 eye diseases and prescribed 143 drugs to treat these diseases.

Ibn al-Haytham (965 – 1039) an Arab scientist, made significant contributions to the principles of eye and vision. He is regarded as the father of optics (study of the behaviour of light). His "Book of Optics" correctly explained and proved the modern theory of vision. He discussed the topics of medicine and eye surgery in his book. He made several improvements to eye surgery and accurately described the process of sight, the structure of eye, image formation in eye and visual system. Ibn al-Haytham also described the principles of pinhole camera.

Q.11 Explain the structure of human ear in detail. Describe its functioning in balancing of body.

Ans. Ear

Hearing is as important as vision. Our ear helps us in hearing and also to maintain the balance or equilibrium of our body.

Structure of Ear

Ear has three main parts i.e.

(a) External ear (b) Middle Ear (c) Internal Ear

(a) External Ear

Parts of external ear

External ear consists of pinna, auditory canal and eardrum (tympanum).

PINNA

Pinna is the broad external part, made of cartilage and covered with skin.

AUDITORY CANAL

Pinna helps to direct sound waves into auditory canal. There are special glands in the walls of auditory canal which produce wax.

Function of hair and wax

The hair and the wax in auditory canal protect ear from small insects, germs and dust. They help to maintain the temperature and dampness of auditory canal.

EAR DRUM

Auditory canal ends in ear drum. This thin membrane separates external ear from the middle ear.

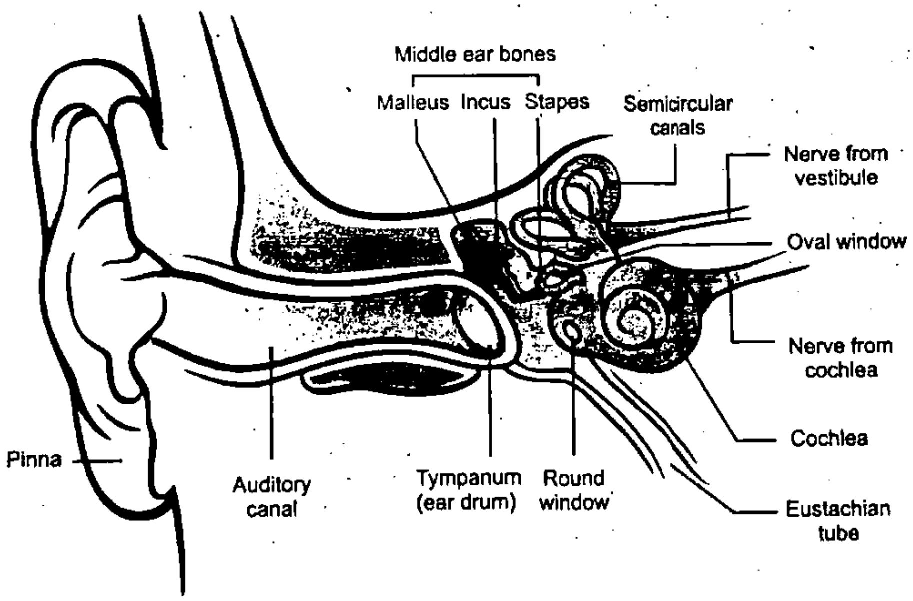


Figure 12.10: Structure of human Ear

(b) Middle ear

Middle ear is a chamber after external ear.

Bones

Three small bones, called middle ear ossicles, are present in a chain in middle ear. These moveble bones include malleus, incus and stapes. These three bones are collectively called middle ear ossicles.

Malleus

It is attached with eardrum, then comes incus and finally stapes.

Stapes

It is the smallest bone of body.

Oval window

Stapes is connected with a membrane called oval window. Oval window separates middle ear from inner ear. Middle ear also communicates with the nasal cavity through eustachian tube.

Function of Eustachian tube.

This tube regulates the air pressure on both sides of ear drum.

(c) Inner ear

Parts of inner Ear

Inner ear consists of three parts i.e. vestibule, semicircular canals and cochlea.

Vestibule

It is present in the centre of inner ear.

Semicircular canals

Three canals called semicircular canals are posterior to the vestibule.

Cochlea

The cochlea is made of three ducts and wraps itself into a coiled tube.

Sound Receptor cells

Sound receptor cells are present within the middle duct of cochlea.



Figure: 12.11: Structure of the inner Ear

The process of hearing

The pinna of the external ear focuses and directs sound waves into auditory canal. The sound waves strike ear drum and produce vibrations in it. From ear drum, the vibrations strike middle ear and produce further vibrations in malleus, incus and then stapes. From stapes, the vibrations strike the oval window and then reach the fluid-filled middle duct of cochlea. The fluid of cochlea is moved and receptor cells are stimulated. The receptor cells generate a nerve impulse, which travels to brain and is interpreted as sound.

Ears maintain the balance of body

Semicircular canal and vestibule help to maintain the balance of body. Semicircular canals contain sensory nerves which can detect any movement of head. Vestibule can detect any change in the posture of body. The neurons coming from these two receptors reach cerebellum through the auditory nerve.

Q.12 What is endocrine system. Describe important endocrine glands.

Ans. Endocrine Glands

Introduction

Endocrine system regulates the activities such as growth, reproduction, maintenance of glucose concentration in blood, reabsorption of water in kidneys etc.

Hormones

Endocrine system uses chemicals to communicate with its effectors. These chemicals are known as hormones. A hormone is a specific messenger molecule synthesized and secreted by endocrine gland.

Types of Gland

They are of two types:

(a) Endocrine Gland

These glands are ductless and release their secretions (hormones) directly into the blood stream. Blood carries the hormone to the target organs or tissues upon which they act.

(b) Exocrine glands

Many glands in our body are exocrine. Such glands have ducts for releasing their secretions e.g. digestive glands, skin glands etc.

Important Endocrine glands

1. Pituitary Gland

Structure

It is a pea-shaped gland.

Location

It is attached to the hypothalamus of brain.

Hormones

Many hormones of pituitary gland influence the secretions of other endocrine glands. However some hormones of this gland act directly on various tissues of body.

Lobes of pituitary gland

There are two lobes of pituitary gland.

(a) Anterior lobe

Hormones

It produces many hormones.

(i) SOMATOTROPHIN

One of its important hormone is somatotrophin (growth hormone).

Function

It promotes the growth of body.

Deficiency – Dwarfism

If the production of this hormone is diminished during growing age, the rate of growth decreases. This condition is called dwarfism.

Over Production-Gigantism

If this hormone is excessively produced after growing age, it leads to gigantism (very tall and overweight).

Acromegaly

If this hormone is excessively produced after growing age, internal organs and body extremities alone grow large. This condition is known as acromegaly. Such persons will have large hand, feet and jawbones.

(ii) Thyroid stimulating hormone

Another important hormone secreted by the anterior lobe of pituitary gland is Thyroid Stimulating Hormone (TSH).

Function

It stimulates thyroid gland to secrete its hormones. The remaining hormones of anterior lobe influence reproductive organs and also control adrenal glands.

(b) Posterior Lobe

(a) Hormones

The posterior lobe of pituitary gland stores and secretes two hormones i.e. oxytocin and vasopressin (Antidiuretic Hormone ADH).

(b) Production of Hormones

These hormones are produced by hypothalamus.

Functions

(i) Vasopressin

(a) Retaining water and less amount of urine

It increases the rate of reabsorption of water from nephrons. When we have low amount of water in body fluids, pituitary gland secretes vasopressin and so more reabsorption of water occurs from nephrons into blood. In this way, body retains water and less amount of urine is produced.

(b) Less water reabsorption and more amount of urine

On the other hand, when body fluids have more than normal water, there is a decline in the secretion of this hormone. If pituitary gland does not secrete this hormone in the required amount, less water is reabsorbed from nephrons and there is excessive loss of water through urine. This condition is known as diabetes insipidus.

(ii) Oxytocin

This hormone stimulates the contraction of uterus walls in mothers for child birth.

It is necessary for the ejection of milk from breast.

2. Thyroid Gland

This is the largest endocrine gland in the human body. It produces two hormones.

Location

It is present in neck region below the larynx.

i. Thyroxin Hormone

It produces a hormone thyroxin. Iodine is required for the production of this hormone.

Deficiency

If a person lacks iodine in diet, thyroid gland cannot make its hormone. In this condition, thyroid gland enlarges. This disorder is called goitre.

Overproduction of Hormone

Hypothyroidism is caused by the under production of thyroxin.

Effects

Low energy production in body, slowing down of heartbeat.

Over –production

Hyperthyroidism is caused by over-production of thyroxin.

Effects / Symptoms

(i) Increase in energy production

(ii) Increase heart beat

(iii) Frequent sweating

(iv) Shivering of hands

Function of Thyroxin

Thyroxin increases the breakdown of food (oxidation) and releases energy in body. It is also responsible for the growth of body.

ii. Calcitonin Hormone

The thyroid gland produces another hormone called calcitonin.

Effects

It decreases the level of calcium ions in blood and promotes the absorption of calcium from blood into bones.

3. Parathyroid gland

Location

These are four glands situated on the posterior side of thyroid gland.

Hormone

This gland produces a hormone known as parathormone.

Function

It increases the level of calcium ions in blood.

Over – production

When there is an increased production of parathormone, more than normal calcium salts are absorbed from the bones and added to blood. Consequently, the bones become brittle.

Deficiency

If there is deficiency in the production of parathormone, blood calcium level falls. It leads to tetany which affects the function of muscles.

4. ADRENAL GLANDS

Location

Two adrenal glands are situated above the kidneys.

Structure

Each adrenal gland consists of two parts;

i. Cortex

The outer part is cortex.

ii. Medulla

The inner part is medulla.

Hormone of adrenal medulla

Adrenal medulla secretes a hormone called epinephrine or adrenaline in response to stress.

Emergency Hormone

It prepares our body to overcome emergency situation. Therefore adrenaline is also termed as an emergency hormone.

Hormone of Adrenal cortex

The adrenal cortex secretes many hormones called corticosteroids which maintain the balance of salts and water in blood.

5. Pancreas

This organ has two functions:

Pancreas as Exocrine Gland

The major part of pancreas is a ducted (exocrine) gland. This portion secretes digestive enzymes through a duct into the small intestine.

Pancreas as Endocrine Gland

Some portions of pancreas serve as ductless (endocrine) gland. This portion contains groups of endocrine cells referred to as Islets of Langerhans.

Hormones of Islets of Langerhans

The islets secrete two hormones i.e. insulin and glucagon.

(i) GLUCAGON

It influences the liver to release glucose in blood and blood glucose concentration rises.

(ii) INSULIN

It influences the liver to take excess glucose from blood and so the blood glucose concentration falls.

Deficiency of insulin

If a person's pancreas does not make normal quantity of insulin, the blood glucose concentration rises and the person suffers from diabetes mellitus.

Symptoms of diabetes

Persons with diabetes have:

i. Loss of weight
ii. Weakening of muscles
iii. Tiredness

Treatment of diabetes

Diabetes can be controlled by insulin administration. Formerly insulin extracted from animals was used for this purpose. But now human insulin produced from bacteria through genetic engineering is available.

6. GONADS

Definition

Testes and ovaries are the male and female reproductive organs respectively. They are collectively called gonads.

Testes

Testes secrete hormones e.g. testosterone, which is responsible for the development of male secondary sex characters such as growth of hair on face and coarseness of voice etc.

Ovaries

Ovaries secrete estrogen and progesterone which are responsible for the development of female secondary characters such as the development of breast.

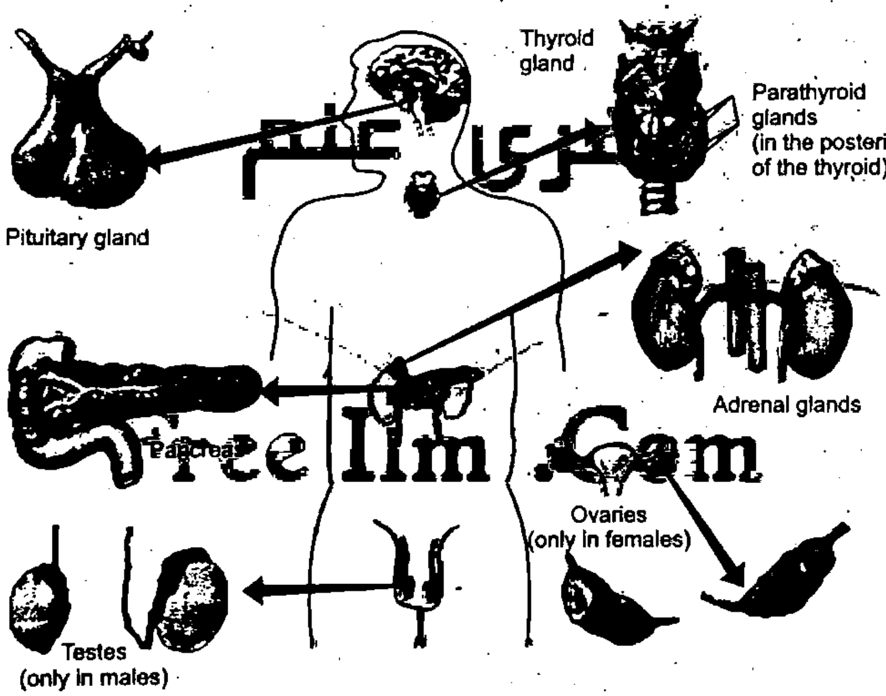


Figure 12.12: Endocrine Glands in Human body

Q.13 What do you mean by feedback Mechanism? Explain.

Ans. Feedback Mechanism

Endocrine glands do not secrete their hormones at a constant rate. The rate varies with the needs of the body. Like many other functions in body, the secretion of hormones is also regulated by feedback mechanisms.

Definition:

Feedback mechanism means the regulation of a process by the output of the same process.

Types:

Feedback mechanisms are of two types i.e. positive and negative feedbacks.

In negative feedback, the output of a process decreases or inhibits the process. This mechanism works to return a condition towards its normal value. For example, when the blood glucose concentration rises, pancreas secretes insulin. It decreases the blood glucose concentration. Decline in the blood glucose concentration to a normal set-point inhibits the secretion of insulin. In other words, the blood glucose concentration (output) controls the process i.e. the secretion of insulin and glucagon.

In positive feedback the changes resulting from a process increase the rate of process. For example, suckling action of an infant stimulates the production of a hormone in mother. This hormone works for the production of milk. More suckling leads to more hormones which in turn leads to more milk production.

Q.14 Explain the disorders of Nervous system.

Ans. Disorders of nervous system can be categorized into two main types i.e.

(i) Vascular Disorders

Vascular disorders are due to any disturbance in the blood supply to nervous system e.g. paralysis.

Paralysis

Paralysis is the complete loss of function by one or more muscle groups. Patients may have weak paralysis throughout his or her body or have paralysis in the lower extremities or in all four limbs

Causes

Following are the causes of paralysis:

(i) It is most often caused by damage to the central nervous system (brain or spinal cord). The damage may be due to stroke i.e. rupture in a blood vessel of brain or spinal cord.

(ii) Blood clotting in blood vessels.

(iii) Poison produced by polio viruses.

(ii) Functional Disorders

Functional disorders are due to any disturbance in nerve impulse generation and transmission e.g. epilepsy.

Epilepsy

Epilepsy is a nervous disorder in which there is abnormal and excessive discharge of nerve impulses in brain. It causes unprovoked seizures in patient. A seizure of epilepsy is a temporary abnormal state of brain marked by convulsions.

Causes

In younger people, epilepsy may be due to genetic or developmental causes.

In people over age 40 years brain tumours are more likely to cause epilepsy.

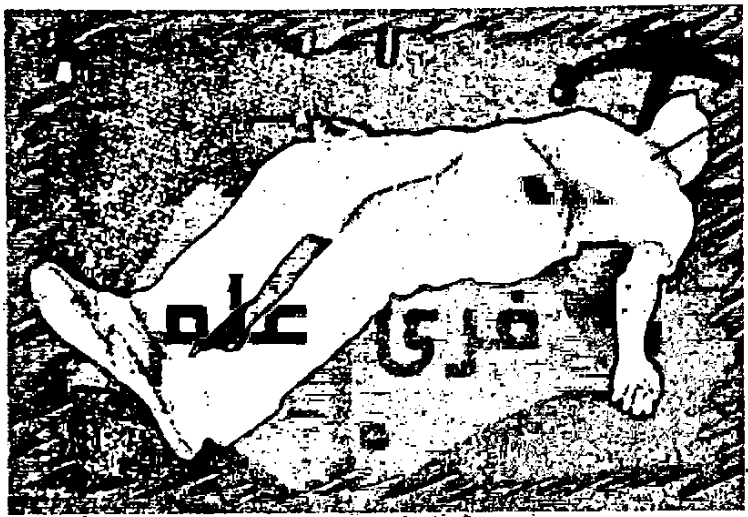
Head trauma and central nervous system infections may cause epilepsy at any age.

Cure

There is no known cure of epilepsy but medicines can control seizures.

Treatment

Patients of epilepsy have to take medicines daily for the treatment as well as the prevention of seizures. These medicines are termed as anticonvulsant or antiepileptic drugs.



Unit 13

Support and Movement

Long Answer Questions

Q.1 What do you mean by Support and movement?

Ans. Introduction

Multicellular organisms having greater sizes, need support to keep their body mass as one unit. This is particularly true for those organisms who live on land. In human, skeleton is responsible for support and movement.

(1) Movement: Movement is a general term meaning the act of changing place or position by entire body or by its parts. There are two types of movements:

1) Movement of body parts
2) Locomotion

(II) Locomotion: Locomotion is the movement of an animal as a whole from one place to another.

Q.2 Define human skeleton. Describe its types and role.

Ans: Skeleton

Skeletal system or skeleton is defined as the framework of hard articulated structures that provide physical support, attachment for skeletal muscles and protection for bodies of animals.

Types of skeleton

It is of two types:

(i) Endoskeleton: The skeleton which is present on inside the body is called endoskeleton. e.g. in Vertebrates and Human.

(ii) Exoskeleton: The skeleton which is present outside of the body e.g. in arthropods.

Parts of Skeleton: There are two parts of skeleton:

1) Cartilage
2) Bones

In the living body, skeleton is very much alive. Bones and cartilage are made up of living cells having nerves and blood vessels in them. They grow and have the ability to repair themselves.

Role of Skeleton system: Skeletal system provides:

1) Movements
2) Protection
3) Support

1-Movements: Skeleton works very closely with the muscular system to help the body for movement.

2-Protection: Skeleton provides protection to many of our internal organs e.g. skull protects brain, vertebral column protects spinal cord and ribs protect many organs especially heart and lungs.

3- Support: Skeleton provides support to our body mass e.g. vertebral column provides main support to our body mass.

Q.3 Write a note on cartilage and bone in Human skeleton?

Ans. Introduction

Overall, the human skeleton is made of bony framework but in certain parts, this frame work is supplemented by cartilage.

Connective Tissue

Both cartilage and bones are types of connective tissues in animals. Most of the connective tissues contain collagen fibres in a matrix.

Explanation

(i) Cartilage

Definition

Cartilage is a dense, clear blue-white firm connective tissue but less strong than bone.

Chondrocytes

The cells of cartilage are called chondrocytes.

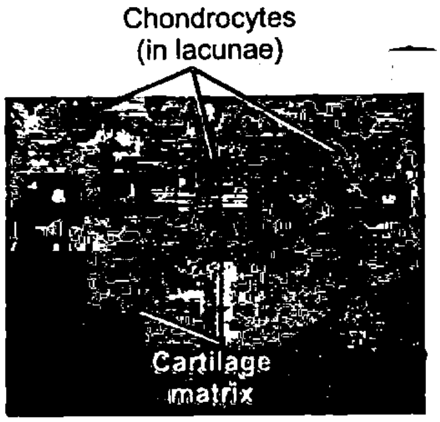


Figure 13.1: Chondrocytes in cartilage matrix

Lacuna

Each chondrocyte lies in a fluid space called lacuna present in the matrix of cartilage.

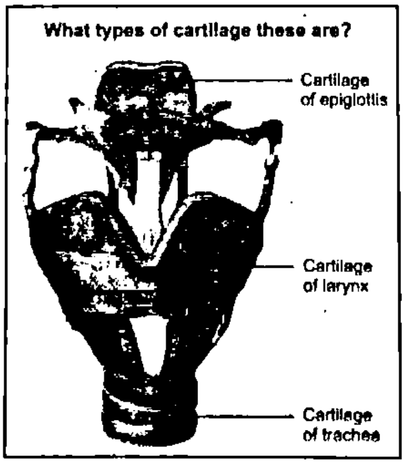
Collagen Fibres

The matrix of cartilage also contains collagen fibres.

No Blood vessels in cartilage

Blood vessels do not enter cartilage.

Types of Cartilage **(Board 2014)**



There are three types of cartilage:

1. Hyaline cartilage
2. Elastic Cartilage
3. Fibrous cartilage

1) **Hyaline Cartilage:** Hyaline cartilage is strong and flexible cartilage. It is found covering the ends of the long bones, in the nose, larynx, trachea and bronchial tubes.

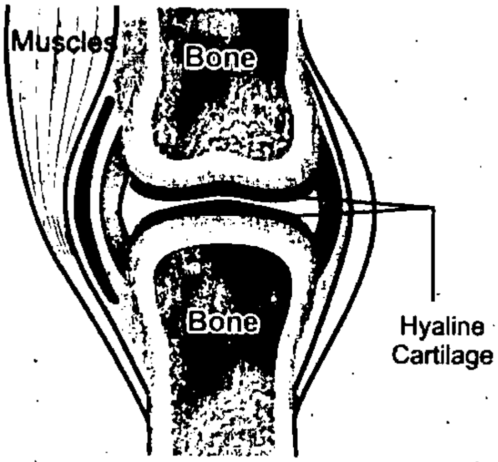


Figure 13.2: Hyaline cartilage

2) **Elastic Cartilage:** Elastic cartilage is similar to hyaline cartilage. It is also quite strong but has elasticity due to a network of elastic fibers in addition to collagen fibers. It is found in epiglottis and pinna etc.

3) **Fibrous Cartilage:** Fibrous cartilage is very tough and less flexible due to large number of their collagen fibers present in knitted form. It is found in intervertebral discs.

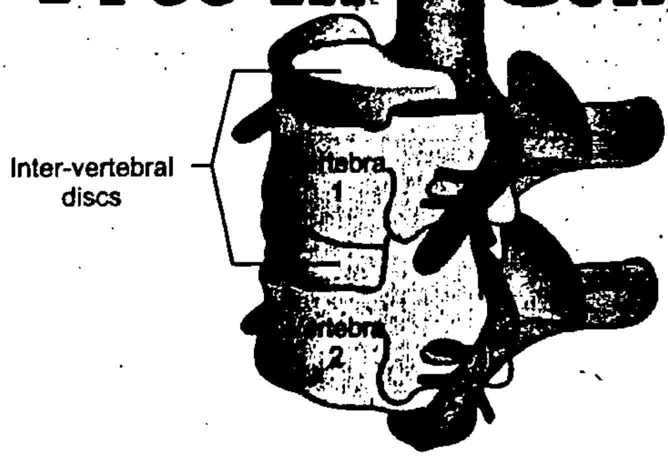


Figure 13.3: Fibrous cartilage

(ii) Bone:

Definition

Bone is the hardest connective tissue in body. Bones not only move, support and protect the various parts of body but also produce red and white blood cells and store minerals.

Structure of a bone

1) **Compact bone** The hard outer layer of a bone is called compact bone.
2) **Spongy bone** Interior of bone is soft and porous called spongy bone, it contains blood vessels and bone marrow. Babies are born with about 300 soft bones some of these bones later fuse together, so that the adult skeleton has 206 hard bones.

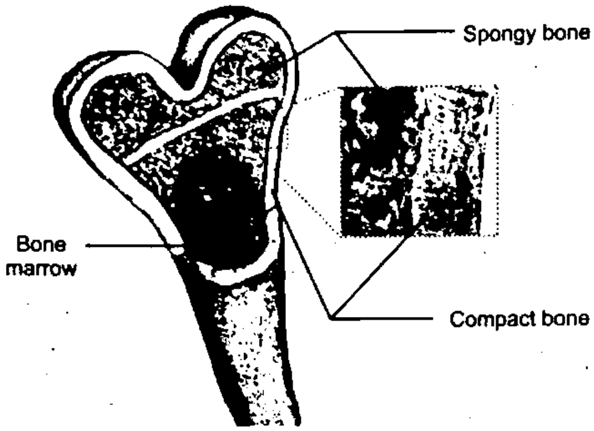


Figure 13.4: compact and spongy bone

3) **Matrix of bones** Like cartilage, the matrix of bones also contains collagen. But it also contains minerals e.g. calcium and phosphate. Bones contain different types of cells,
4) **Osteocyte**
Mature bone cells are called osteocytes.

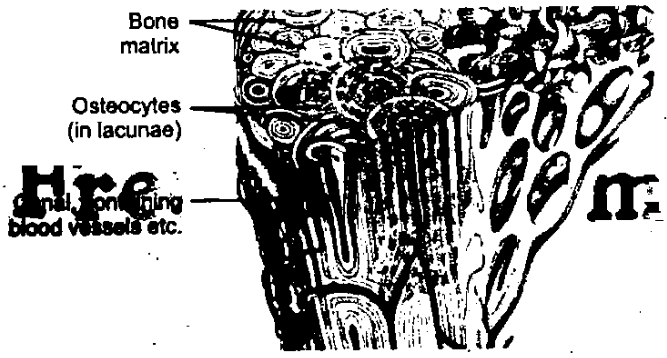


Figure 13.5: The internal structure of bone

Q.4 What are the components of human skeleton?

Ans. Introduction

206 bones are present in the adult human skeleton. Skeleton can divide into two parts:

1. **Axial Skeleton** Bones are organized into a longitudinal axis i-e axial skeleton. Axial Skeleton consists of 80 bones in the head and trunk of body.

Parts

It is composed of five parts:

i. **Skull** Contains 22 bones out of which 8 are cranial bones (enclosing the brain) and 14 are facial bones.
ii. **Middle ear ossicles** 6 bones are present in middle ear (3 in each ear).
iii. **Hyoid bone** It is present in neck.
iv. **Vertebral column** It contains 33 bones and these bones are called vertebrae.
v. **Chest** Chest is made up of a chest bone called sternum and ribs. 24 ribs are present in 12 pairs.

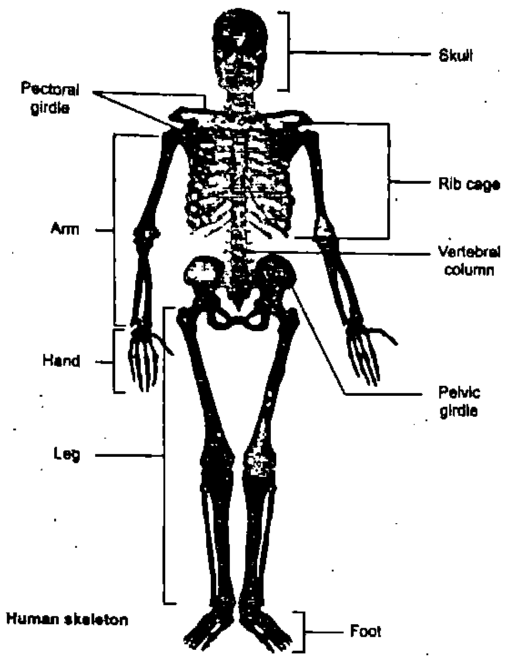


Figure 13.6: Human Skeleton

2. Appendicular skeleton:

Apendicular skeleton is attached to the axial skeleton. Appendicular skeleton is composed of 126 bones.

Parts

It is divided into two parts.

1) **Pectoral Girdle (Shoulders):** It is called shoulder girdle and made up of 4 bones. Arms have six bones. Both hands have 54 bones.
2) **Pelvic Girdle (hips):** It has two bones. Legs have 6 bones and feet have 54 bones.

Q.5 Define Joint and write down the types of Joints. **(Board 2014)**

Ans. Joints: A joint is a location at which two or more bones make contact. Joints allow movement and provide mechanical support.

Types of joints: Joints can be classified on the basis of degree of movement they allow.

1) Immoveable joints (Fixed)
2) Slightly moveable joints
3) Moveable joints

1. **Immoveable joints:** Such joints allow no movement e.g. the joints between the skull bones.
2. **Slightly moveable joints:** Such joints allow slight or little movements e.g. joints between the vertebrae.

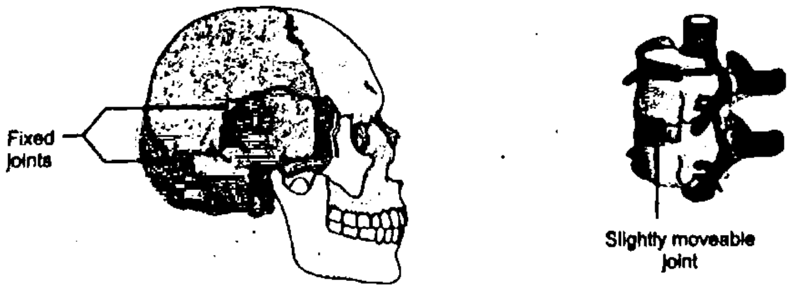


Figure 13.7: Fixed and slightly moveable joints

3. Moveable joints: They show a variety of movements e.g. shoulder joint, hip joint, elbow joint, knee joint etc.

Types of Moveable Joints

There are many types of moveable joints:

1) Hinge joint
2) Ball and socket joint

1. Hinge joints: Hinge joint move back and forth like the hinge on a door and allow movements in one plane only. The knee and elbow are hinge joints.

2. Ball and socket joints: These joints allow movement in all directions. The hip and shoulder joints are ball and socket joints..

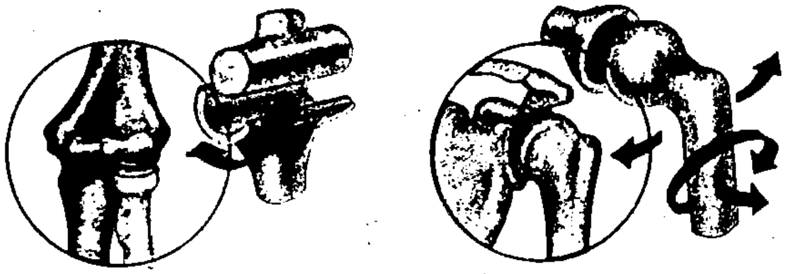


Figure 13.8: Two types of Moveable Joints

Q.6 Describe the role of tendons and ligaments.

Ans Introduction

Tendons and ligaments are bands of connective tissue (made of collagen).

Tendons

Tendons are bands of connective tissues in which collagen fibers are tightly packed. These are tough bands which attach muscles to bones. When muscle contracts, tendon exerts a pulling force on the attached bone, which moves as a result.

Ligaments

Ligaments are also the bands of connective tissues having highly packed collagen fiber. Ligaments are strong but flexible bands and join one bone to another at joints.

Function

They prevent dislocation of bones at joints.

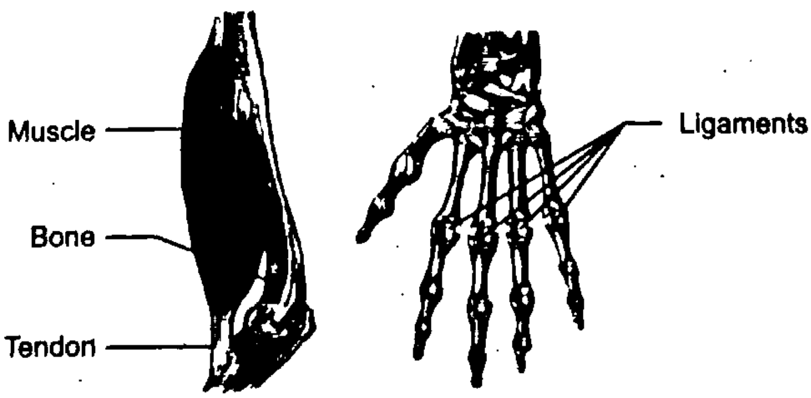


Figure 13.9: Tendons and Ligaments

Q.7 How skeletal muscles, are involved in the movement of the skeleton?

Ans. When bones move at joints, they produce movement. The movements in bones are brought about by the contractions of skeletal muscles, which are attached with bone by tendons. The combination of several muscles bring about activities e.g. walking, running, playing etc.

Origin: One end of skeletal muscle is always attached with some immoveable bone. This end of muscle is called origin.

Insertion: Other end of muscle is attached with a moveable bone and is called insertion.

Muscles can only contract or pull but cannot expand or push the bones. When muscle is stimulated by a nerve impulse, it contracts to become shorter and thicker. Due to this contraction, muscle pulls the moveable bone at insertion.

Role of Skeletal Muscles

(a) Antagonism: Skeletal muscles are usually in pairs of antagonists. In an antagonistic pair, both muscles do opposite jobs. When one muscle contracts the other relaxes and this phenomenon is called antagonism or antagonistic action.

(b) Flexor: When a muscle in an antagonistic pair contracts and bends the joints, it is called flexor muscle and movement is called flexion.

(c) Extensor: When a muscle contracts and straightens the joint, it is known as extensor and the movement is called extension.

Example: (Movement of arm)

(a) Antagonistic Pair

Bicep and triceps are antagonistic pair of muscles and are involved in the movement of arm.

(b) Biceps

Biceps is a flexor muscle in front of the upper arm bone.

(c) Triceps

Triceps is an extensor muscle on the back of arm. Both of these muscles have their origin at pectoral girdle and insertion at one of the two bones of forearm.

(d) Working

When biceps contracts, the forearm (insertion end) is pulled upward. It is flexion of elbow joint. During this flexion, triceps muscle relaxes. When triceps contracts, forearm is pulled down. It is an extension at elbow joint. During it, biceps relaxes. Similar pairs, working antagonistically across other joints, provide for almost all the movements of skeleton.

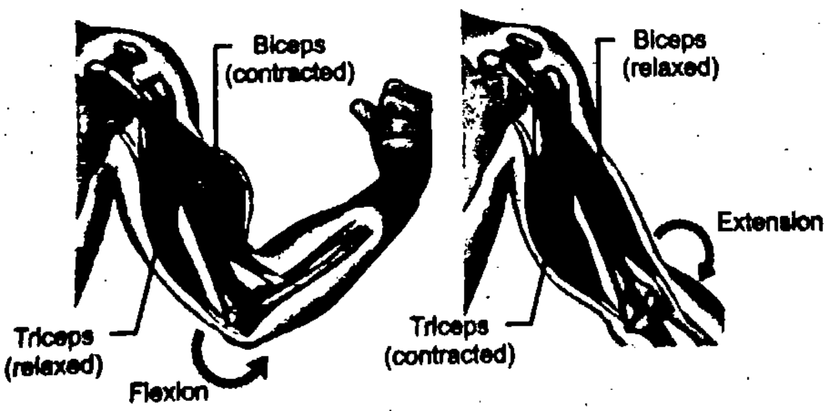


Figure 13.10: Action of Antagonistic Muscles (Biceps and Triceps) at Elbow

Q.8 Write a note on disorders of skeletal system?

Ans. The following are the disorders of skeletal system:

1. **Osteoporosis:** In Osteoporosis, there is a decrease in the density of bones due to the loss of calcium and phosphorus. It is a bone disease in adults especially in old people. It is more common in old women. In women, estrogen deposits minerals in bones. When reproductive cycle stops in female, not enough estrogen is secreted and no minerals are deposited at bones and women becomes victim of osteoporosis.

Causes:

i. Malnutrition (lack of protein and Vitamin C)
ii. Lack of physical activities
iii. Deficiency of estrogen hormone in women
iv. Decrease in the secretion of growth hormones in old age and it also leads to decreased deposition of minerals in bone matrix.

2. **Arthritis**

Introduction: Arthritis means "inflammation in joints". It is also very common in old age and in women.

Symptoms

It is characterized by pain and stiffness in joints particularly in the weight bearing joints e.g; in hip joint and ankle joint etc.

Treatment

It includes pain killer and anti-inflammatory medicines.

Types of Arthritis:

1) Osteoarthritis

It is due to the degeneration in the cartilage present at joints or due to decreased lubricant production at joints. In this arthritis, fusion of the bones at joint may occur and joints may become totally immoveable.

2) Rheumatoid arthritis

It involves the inflammation of the membranes at joints. Its symptoms include fatigue, low grade fever, pain and stiffness in joints.

3) Gout: It is characterized by the accumulation of uric acid crystals in moveable joints. It generally attacks the toe joints.

Unit 14

Reproduction

Long Answer Questions

Q.1 Define reproduction. Write its importance?

Ans: Reproduction

It is defined as the production of individuals of the same species i.e. the next generation of species.

Importance

(a) Continuation of species

Reproduction is essential for the continuation of species.

(b) Transmission of genetic material

It ensures that the genetic material of one generation is transmitted to the next. Each generation produces more offsprings for the next generation. Only the fittest and the best survive and reach the reproductive age.

This ensures that the advantageous characteristics are transmitted to the next generation.

Q2. Define asexual reproduction. Describe the different methods of asexual reproduction.

Ans. Definition

Asexual reproduction is simple cell division that produces an exact duplicate of an organism. It does not involve the fusion of gametes.

Types of Asexual Reproduction

There are many types of asexual reproduction, they produce individuals that are genetically identical to each other and to the parent.

(1) Binary fission

(a) Introduction

Binary fission means "division into two", it is the simplest and most common method of asexual reproduction.

(b) Occurrence

Binary fission occurs in prokaryotes (Bacteria), many unicellular eukaryotes e.g. protozoa and some invertebrates.

(c) Examples

(i) Binary Fission in Bacteria

(i) During binary fission in bacteria, the DNA is duplicated and so two copies of DNA are formed.

(ii) The two copies move towards the opposite poles of the cell.

(iii) The cell membrane invaginates in centre and divides the cytoplasm into two.

(iv) New cell wall is deposited between the two cross walls. It results in the formation of two daughter bacteria, which grow in size and divides again.

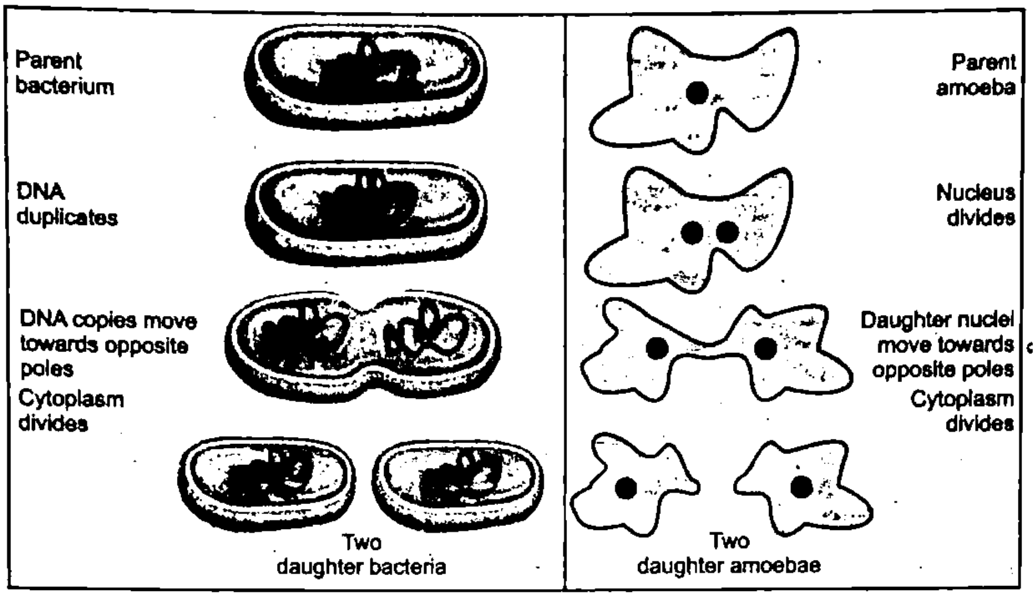


Figure 14.1: Binary fission in a bacterium (Left) and in an amoeba (right)

(ii) Binary fission in unicellular Eukaryotes (*Amoeba*)

It occurs in the following way:

(i) The nucleus of parent organism divides into two by mitosis.

(ii) It is followed by the division of cytoplasm.

(iii) So two daughter cells of almost equal size are formed.

(iv) Daughter cells grow in size and then divide again`.

(iii) Binary fission in invertebrates

During this asexual reproduction, body is cut into two halves and the missing body parts are regenerated in both halves. e.g., planaria and many echinoderms.

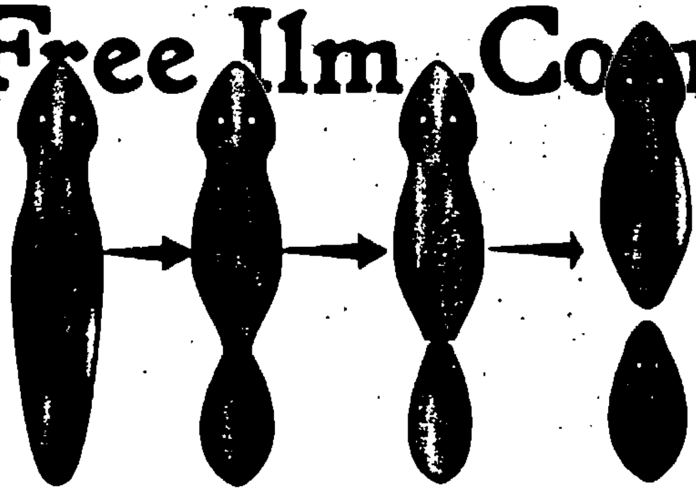


Figure 14.2: Binary Fission in a Planarian

(2) Fragmentation

Introduction

In fragmentation, certain worms grow to full size, they spontaneously break up into 8 or 9 pieces. Each piece develops into a mature worm and the process is repeated.

Example

If a planarian breaks into many pieces instead of two, it will also be called as fragmentation.

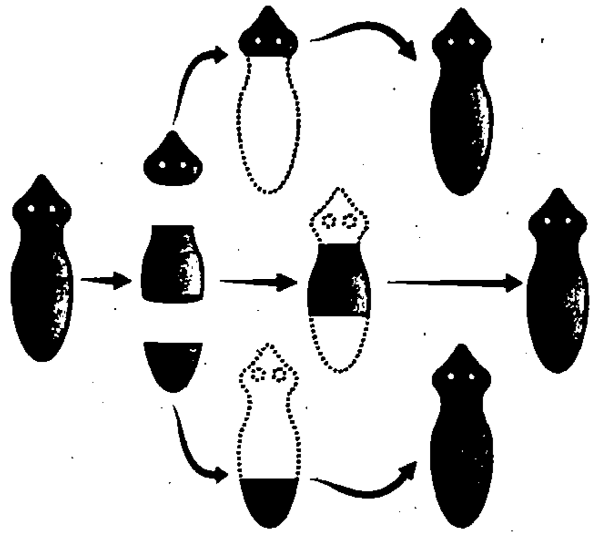


Figure 14.3: Fragmentation in a Planarian

(3) Budding / Explain budding with example. (Board 2014)

(a) Definition

In budding, a bud develops as a small outgrowth on parent's body.

(a) Budding in yeast

(i) In yeast, a small bud is formed on one side of the cell.

(ii) The nucleus of the cell divides and one of the daughter nuclei is passed into the bud.

(iii) Parent cell may form more than one bud at a time.

(iv) Each bud enlarges and may separate from parent body.

(v) In some cases, the buds never separate and as a result, colonies of individuals are formed.

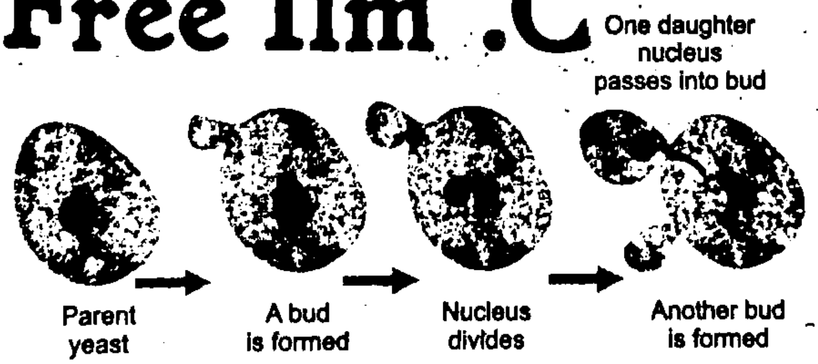


Figure 14.4: Budding in Yeast

(b) Budding in sponges, hydra and corals

(i) A small bud is formed on the side of bodies of these organisms, by mitosis.

(ii) This bud enlarges by the formation of more cells.

(iii) It then detaches from the parent body and grows into new organisms in hydra. But in corals, the buds do not detach and form big colonies.

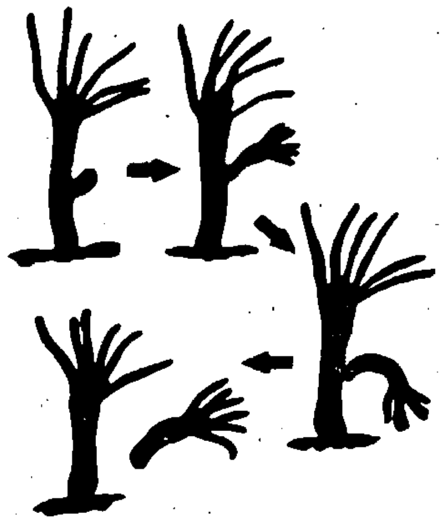


Figure 14.5: Budding in hydra

4- Spore formation

(a) Introduction

It is generally seen in most fungi.

(b) Examples

(i) Spore formation in *Rhizopus*

When *Rhizopus* reaches the reproductive age, its body cells form thick walled spore sacs called sporangia (sing: sporangium). Inside each sporangium, a cell divides many times and forms many daughter cells, called spores. Each spore is covered by a thick wall called cyst and it survive unfavourable conditions. When sporangia mature, they burst and release spores. Under favourable conditions, the spores germinate and develop into new *Rhizopus*.

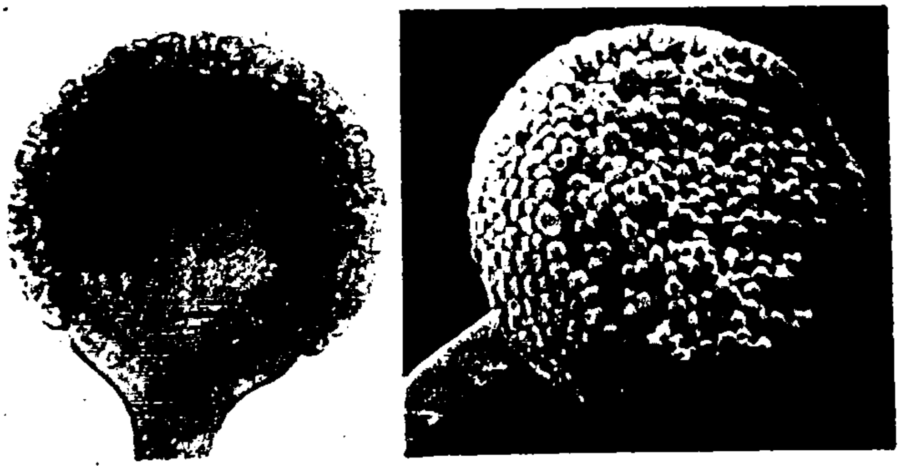


Figure 14.6: Spore Formation in Rhizopus,
mature sporangium (Left), Sporangium bursts (Right)

(ii) Endospore Formation in bacteria

Under unfavourable conditions, some species of bacteria reproduce by forming spores, e.g., *Clostridium* and *Bacillus* species. Thick walled spores are formed inside bacterial cells. They are called endospores.

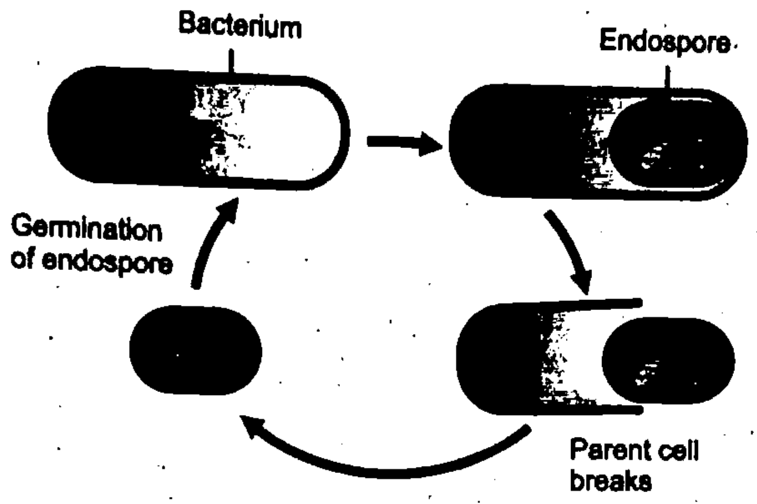


Figure 14.7: Spore Formation in a Bacterium

5- Parthenogenesis

Definition

It is also a form of asexual reproduction. In it, an unfertilized egg develops into new offspring.

Examples

(i) Some fishes, frogs and insects reproduce by means of parthenogenesis.

(ii) Parthenogenesis in Honeybee

Queen honeybee lays eggs in the cells of honeycomb. Many eggs remain unfertilized and develop into haploid males (drones) by parthenogenesis and eggs that are fertilized by male bees develop into diploid females.

6- Vegetative Propagation

Definition

The process in which vegetative parts of plants i.e. roots, stems or leaves give rise to new plant is called vegetative propagation.

Occurrence

It occurs naturally and artificially.

(1) Natural Vegetative Propagation

It occurs naturally in several ways.

(i) Bulbs

Definition

Bulbs are short underground stems surrounded by thick, fleshy leaves that contain stored food.

Explanation

Adventitious roots arise from the base of bulb while shoots arise from the top of the base.

Examples: Tulips, onions and lilies reproduce by bulbs

(ii) Corms

Introduction

Corms are short and swollen underground stems containing stored food.

Explanation

Buds are present at the top of corm. Shoot grows from a bud and forms a new plant.

Examples

Dasheen and garlic

(iii) Rhizomes

Introduction

These are horizontal underground stems with scale leaves.

Explanation

Enlarged portions on rhizome are called nodes. Buds are produced at nodes which give rise to shoot. The lower surface of rhizome produces adventitious roots.

Examples

Ginger, ferns and water lilies reproduce by rhizomes.

(iv) Stem Tubers

Definition

These are the enlarged portions of an underground stem (rhizome).

Explanation

There are aggregations of tiny buds in the form of "eyes" along the surface of tuber. Each bud develops into shoot that grows upward and also produces roots.

Examples

Potatoes and Yams

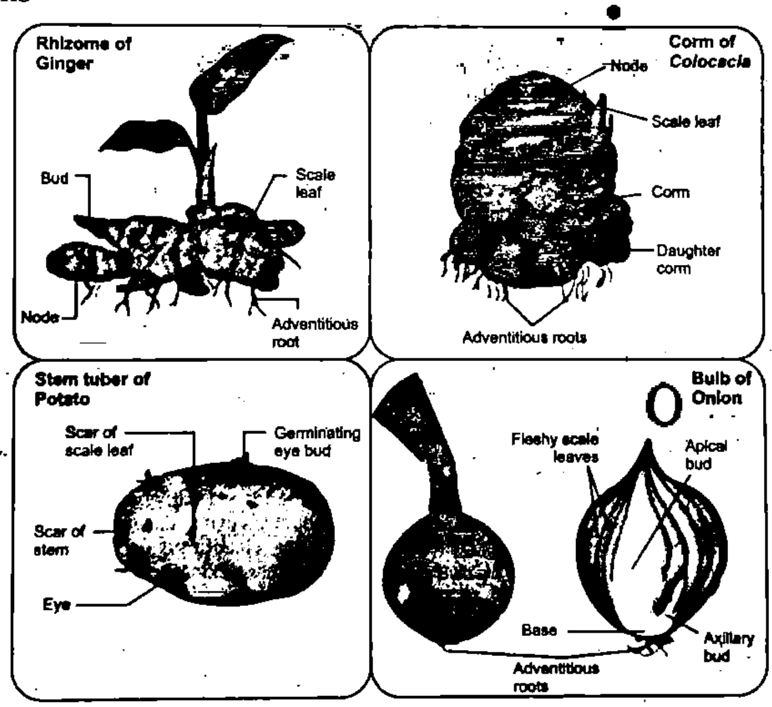


Figure 14.8: Some Types of Natural Vegetative Propagation

(v) Suckers

Definition

Suckers are lateral stems close to ground level.

Explanation

A sucker grows underground from some distance and then turn up, producing the new plant.

Example

Mint and *chrysanthemum*

(vi) By Leaves

Introduction

Vegetative propagation by leaves is not common and is seen in plants such as *Bryophyllum* (*Pather Chut*).

Explanation

This plants has fleshy leaves and adventitious buds are present at the margins of leaves. When leaf falls on ground, the buds grow into new plants.



Figure 14.9: A Bryophyllum leaf with Buds

2- Artificial Vegetative Propagation

The following two are the most common methods of artificial vegetative propagation:-

(i) Cuttings

Introduction

In this method, cuttings may be taken mainly from the stems or roots of parent plant. These cuttings must have a meristematic region from which growth can occur. When cuttings are placed in a suitable soil (sufficient nutrients, water and sunlight), they form roots and shoots which develop into a new plant identical to parent.

Examples

Stem Cuttings

Roses, ivy, grapevines, and sugarcane

Root Cuttings

Sweet potato is an enlarged root. Farmers place it in moist sand or soil until it produces several plantlets. Then the plantlets are removed and planted. This process is used to produce many plants from a single plant and all plants are same. This method has been very beneficial on sugarcane plantation.

(ii) Grafting

Introduction

In grafting, a piece of stem is cut from the plant and is attached with another plant with established root system. After a while, the vascular bundles of the attached stem piece and the host plant are connected to each other. The stem piece and the plant begin to grow together.

Examples: Roses, peach trees, plum trees and grapes.

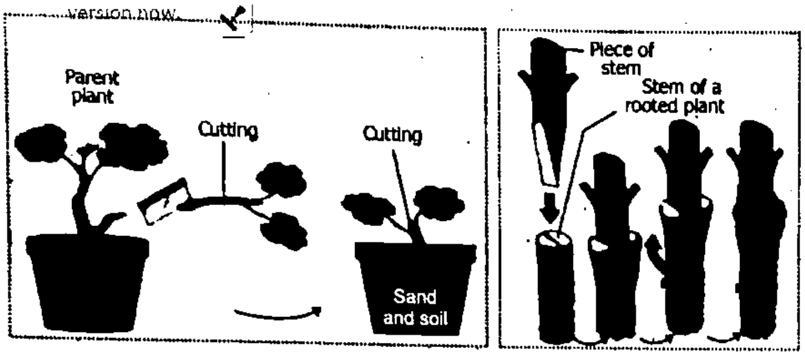


Figure 14.10: Product of Artificial Vegetative Propagation: Cutting (left) and Grafting (right)

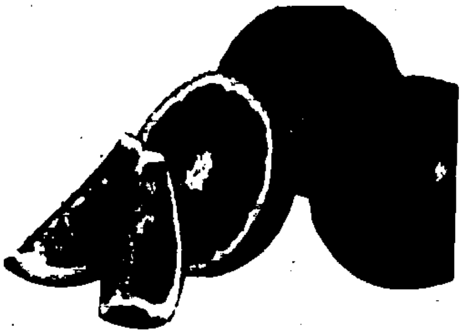


Figure 14.11: Product of Artificial vegetative propagation: Seedless oranges

Q.3 What are advantages and disadvantages of vegetative propagation of plants. **(Board 2014)**

Ans: Advantages

(i) The offsprings produced are genetically identical. Therefore beneficial characteristics can be preserved.

(ii) No need of any mechanism of pollination.

(iii) It helps to increase number of plants at a rapid rate.

(iv) The organs of this method enable many plants to pass over unfavourable conditions.

(v) Seedless fruits can be grown only by vegetative propagation.

Disadvantages

(i) The plants do not have genetic variations.

(ii) Species specific diseases can attack and this can result in the destruction of an entire crop.

Q.4 Describe Tissue culture and Cloning. **(Board 2014)**

Ans: (1) Cloning

Cloning is the latest method of vegetative propagation.

Explanation

Identical offsprings are produced from a single parent using its vegetative tissue or cell.

Micro-Propagation

This method of propagation is also called micro-propagation since it uses only a small part of plant.

(2) Tissue Culture

Introduction

It is the technique applied in cloning.

Explanation

(i) Tissues are taken from any part of plant and are put in a suitable nutrient medium.

(ii) The tissue cells start mitosis and produce masses of cells called calluses which are transferred to other medium containing different hormones.

(iii) Calluses grow into new small plants which are then planted in pots and then in fields.

Q5. Explain the sexual reproduction in plants.

Ans.

1. Sexual Reproduction

Sexual reproduction involves the production of gametes and their fusion i.e., fertilization.

2. Production of Gametes

Gametes are produced in special structures in plant body.

3. Sexually Reproducing Plants

i. Non-Seed Producing plants (Mosses and ferns)

ii. Seed Producing Plants

a. Gymnosperms

b. Angiosperms (flowering plants)

4. Use of Different Methods for Fertilization

Plant groups use different methods for bringing the sperm and egg cells together.

a. In Mosses and Ferns

Sperms are motile and can swim to egg cells. Therefore, these plants require water (in the form of dew or rain) for sexual reproduction.

b. Gymnosperms and anagiosperms

These plants have special methods for carrying their sperms to egg cells. They do not need water for reproduction.

5. Alternation of generation **(Board 2013)**

In the life cycle of flowering plants, two different generations alternate with each other. One generation is diploid and produces spores called sporophyte. The other generation is haploid and produces gametes called gametophyte generation. This phenomenon in which two generations alternate with each other during life cycle is called alternation of generation.

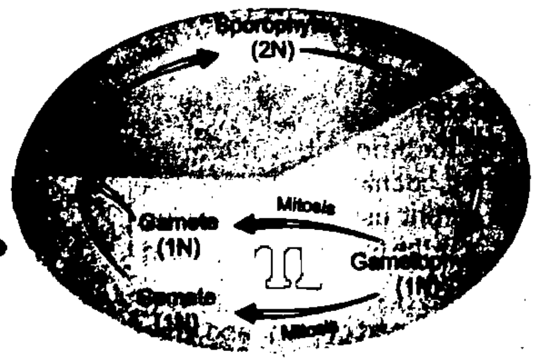


Figure 14.12: An overview of Alternation of generation

6. Sporophyte Generation

i. Dominant

In most plants, sporophyte generation is dominant. It means that it is big in size and is independent.

ii. Production of Spores

Sporopyte produces haploid spores by meiosis and spores develop into gametophyte.

7. Gametophyte Generation

i. Small in size:

It is small in size and depends upon sporophyte.

ii. Production of gametes

It produces gametes by mitosis. The male and female gametes fuse and form diploid Zygote. The zygote undergoes repeated mitosis and develop into a new diploid sporphyte.

8. Structure of flower (Board 2013)

Flower is the reproductive structure. The flower components are arranged in the form of whorls. The outer two whorls in a flower are the non-reproductive whorls while the inner two whorls are the reproductive whorls.

(i) Calyx

It is the outermost whorl and usually green in colour. Its individual units are called sepals.

(ii) Corolla

It is the second whorl and is often coloured brightly. Its individual units are called petals. It attracts the insects which are the agents of pollination.

(iii) Androecium

It is the male reproductive part and its units are called stamens. Each stamen has a thread like filament at the end of which anther is attached. Another has pollen sacs in which haploid microspores (pollen grains) are produced during meiosis. Microspore makes the male gametophyte generation. The nucleus of microspore undergoes mitosis and produces two nuclei i.e. tube nucleus and generative nucleus. The generative nucleus produces two sperms by mitosis. So a germinated microspore has a tube nucleus and two sperms. This is the male gametophyte.

(iv) Gynoecium

It is the female reproductive part of flower. Its units are called carpels. Each carpel is made up of basal ovary, middle style and upper stigma. Inside ovary, there is one to many ovules. Each ovule has one haploid macrospore (produced by meiosis). Macrospore undergoes mitosis and produces an egg cell and some associated structures. This is the female gametophyte.

9. Pollination

When pollen grains mature, they are transferred to stigma and it is called pollination. On reaching the stigma, the tube nucleus of pollen grain makes a pollen tube. The pollen tube contains a tube nucleus and two sperms.

Entry of Sperms in Female gametophyte

The tube grows through style and ovary and enters ovule. Here, it bursts and releases the sperms. Both sperms enter the female gametophyte.

10. Double Fertilization

One sperm fuses with egg and forms a diploid zygote, the other sperm fuses with diploid fusion nucleus and forms a triploid (3N) nucleus called endosperm nucleus. Since the process of fertilization involves two fusions, it is called double fertilization.

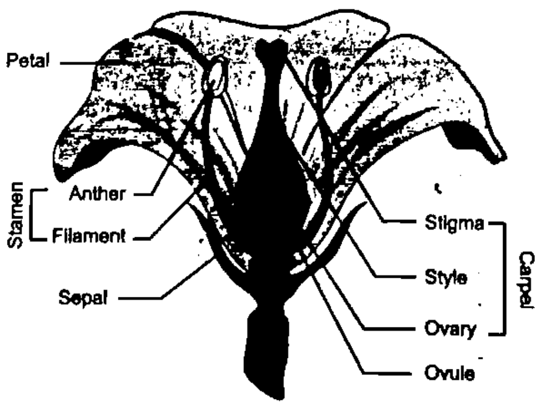


Figure 14.13: Structure of a Flower

11. Formation of embryo and Endosperm

Zygote develops into embryo and endosperm nucleus.

12. Formation of seed and Fruit

Ovule then becomes seed and ovary changes into fruit.

13. Formation of a new plant

When seeds mature, they are dispersed. If seeds get suitable conditions, their embryos develop into new plants.

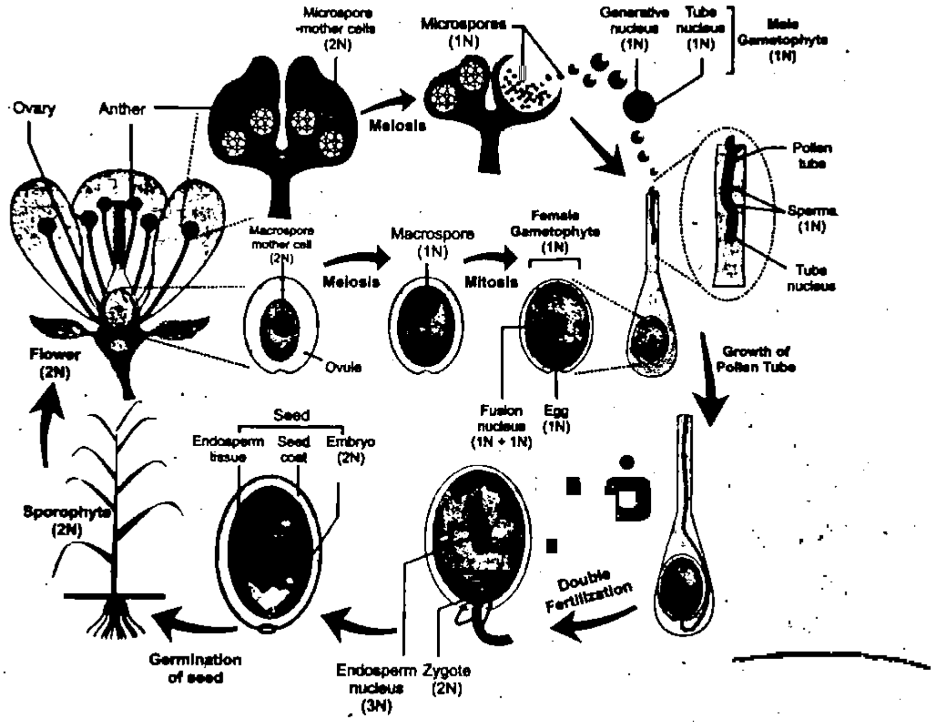


Figure 14.14: Life Cycle of a Flowering Plant

Q6. What is pollination? Write its types.

Ans. Pollination

The transfer of the pollen grains from flower anther to stigma is called pollination.

Types of Pollination

There are two types of pollination:

(i) Self pollination

The transfer of pollen grains from the anther to the stigma of same flower or other flower of same plant is called self pollination.

(ii) Cross pollination

The transfer of pollen grains from the flower on one plant to the flower on other plant of same species. It is brought about by various agencies like wind, water, birds etc. and man.

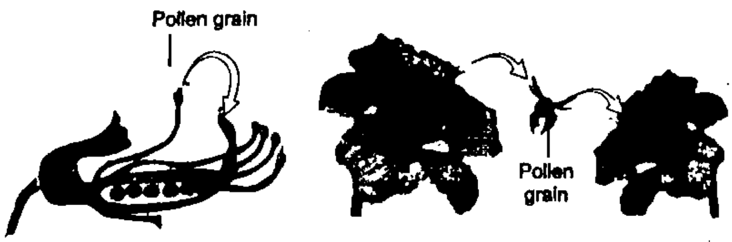


Figure 14.15: Self Pollination (Left) and Cross Pollination (Right)

Q.7 Describe the structural adaptations of insect pollinated and wind pollinated flowers.

Ans: The insect pollinated and wind pollinated flowers have structural adaptations that facilitate the transfer of pollen grains between two plants. Some of these adaptations are described below:

Table 14.1: Adaptations in insect-pollinated and wind-pollinated flowers

Feature	Insect Pollinated Flowers	Wind pollinated Flowers
Size	Generally large	Generally small
Colour	Petals brightly coloured	Petals green or dull in colour
Nectar	Produce nectar	Do not produce nectar
Floral arrangement	Flowers face upwards	Flowers hang down for easy shaking
Stamens and stigmas	Enclosed inside ring of petals	Hang out of ring of petals
Pollen grains	Small number produced/ heavy and sticky	Large number produced/light with smooth surface
Stigma	Pinhead shaped with no branches	Feathery branches for catching pollen
Examples:	Buttercup, rose, wallflower, sunflower, orchid etc.	grasses, hazel, willow, corn etc.



Figure 14.16: Insect-pollinated flower (left) and a wind-pollinated (right) flowers)

Q8. Explain the development and structure of seed.

Ans. Introduction

After fertilization in female gametophyte, zygote divides repeatedly by mitosis and develops into an embryo. At this stage, ovule changes into seed and this completes process of sexual reproduction in plants.

Structure of seed

It consists of three parts

1. Embryo formed from zygote.
2. Endosperm tissue formed from endosperm nucleus.
3. Seed coat developed from the wall of ovule.

Seed coat

It develops from the wall of ovule. It may be a thin or thick layer. Seed coat protects embryo from mechanical injury and from drying out.

Hilum

There is a scar on the seed coat called hilum. It is where the seed is attached to the ovary wall.

Micropyle

At one end of hilum, is micropyle. Seed uses this micropyle for absorption of water.

Development of seed

Emboryo is an immature plant. It consists of a radicle, a plumule and two cotyledons. The radicle of the embryo develops into new root while plumule develops into new shoot. The embryonic stem above the point of attachment of cotyledons is called epicotyl and embryonic stem below the point of attachment of cotyledon called hypocotyl. In angiosperms, the stored food is derived from the endosperm tissue.

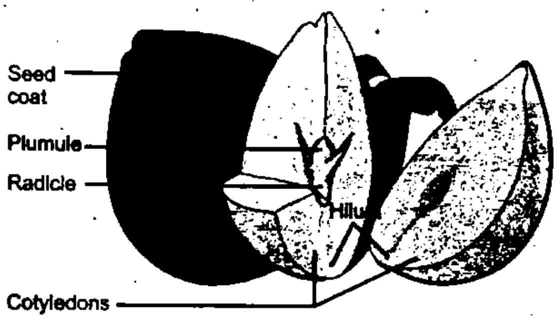


Figure 14.17: The Structure of seed

Q9. Explain the germination of seed.

Ans. Definition

Seed germination is a process by which a seed embryo develops into a seedling.

Process of germination

During germination, the embryo soaks up water which causes it to swell, splitting the seed coat. Root is the first structure that emerges from the radicle present in seed. It grows rapidly and absorbs water and nutrients from soil. In the next phase, plumule develops into tiny shoot which elongates and comes out of soil.

Types of germination

On the basis of elongation of hypoctyl and epicotyl, there are two types of germination:

(i) Epigeal germination

In epigeal germination, the hypocotyl elongates and forms a hook pulling the cotyledons above the ground. Examples are beans, cotton and papaya.

(ii) Hypogeal germination

In this germination, the epicotyl elongates and forms the hook. In this type, the cotyledons stay underground. Examples are pea, maize and coconut.

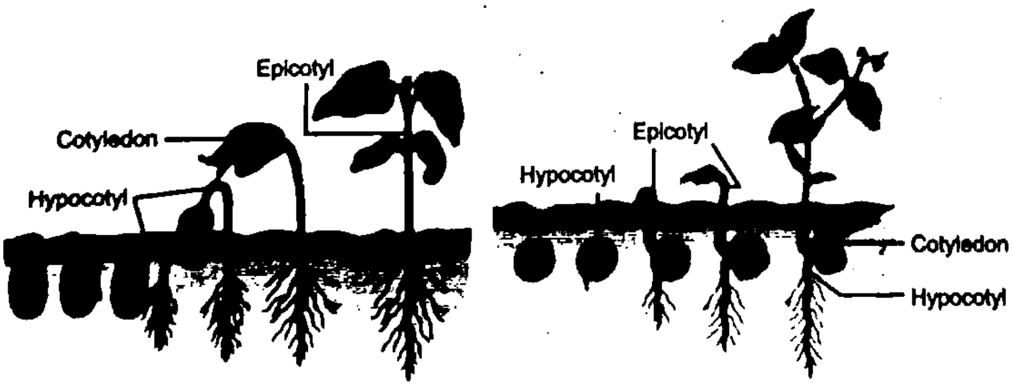


Figure 14.18 Types of Seed Germination. Epigeal (Left) and hypogeal (Right)

Q10. Describe the conditions for seed germination.

Ans. External conditions

The most important external conditions include water, oxygen and favourable temperature.

Water (moisture)

Seeds of most plants have low water content, and germination cannot occur until seed coat or other tissues have imbibed water. The absorbed water is used in the digestion of stored food and helps in elongation of hypocotyl and epicotyl.

Oxygen

Oxygen is essential for the respiration in the cells of embryo.

Temperature

Seeds differ greatly in their temperature, required for germination. The optimum temperature for the germination of the seeds of most plants ranges from 25-30^{0}C.

Internal Conditions

The internal conditions include a live embryo and sufficient food storage.

Q11. What is gametogenesis? Explain the spermatogenesis and oogenesis in detail.

Ans. Definition

The formation of gametes is called gametogenesis.

Explanation

During gametogenesis, diploid (2N) gamete mother cells undergo meiosis and form haploid (1N) gametes. The male and female gametes are formed in specialized organs called gonads.

Male Gonads

Male gonads are called testes and the production of sperms in testes is called spermatogenesis.

Female Gonads

Female gonads are called ovaries and the production of egg cells in ovaries is called oogenesis.

Spermatogenesis

Some cells in the walls of the seminiferous tubules of testes divide repeatedly by mitosis to form large number of diploid spermatogonia. Some spermatogonia produce primary spermatocytes. Each primary spermatocyte undergoes meiosis–I and produces two haploid daughter cells called secondary spermatocytes. By meiosis-II, they produce four haploid spermatids. Their nuclei shrink and some structures are formed e.g. a corner called acrosome, a tail and a mitochondrial ring. After these changes, the spermatids are called sperms.

Oogenesis

Some cells of ovary prepare structures called follicles in which many diploid oogonia are present. Some oogonia produce diploid primary oocytes. One of the primary oocyte produces two haploid cells by meiosis. The smaller cell is called first polar body and the large one is called secondary oocytes. The secondary oocyte completes meiosis II and produces two haploid cells i.e. a second polar body and an egg cell.

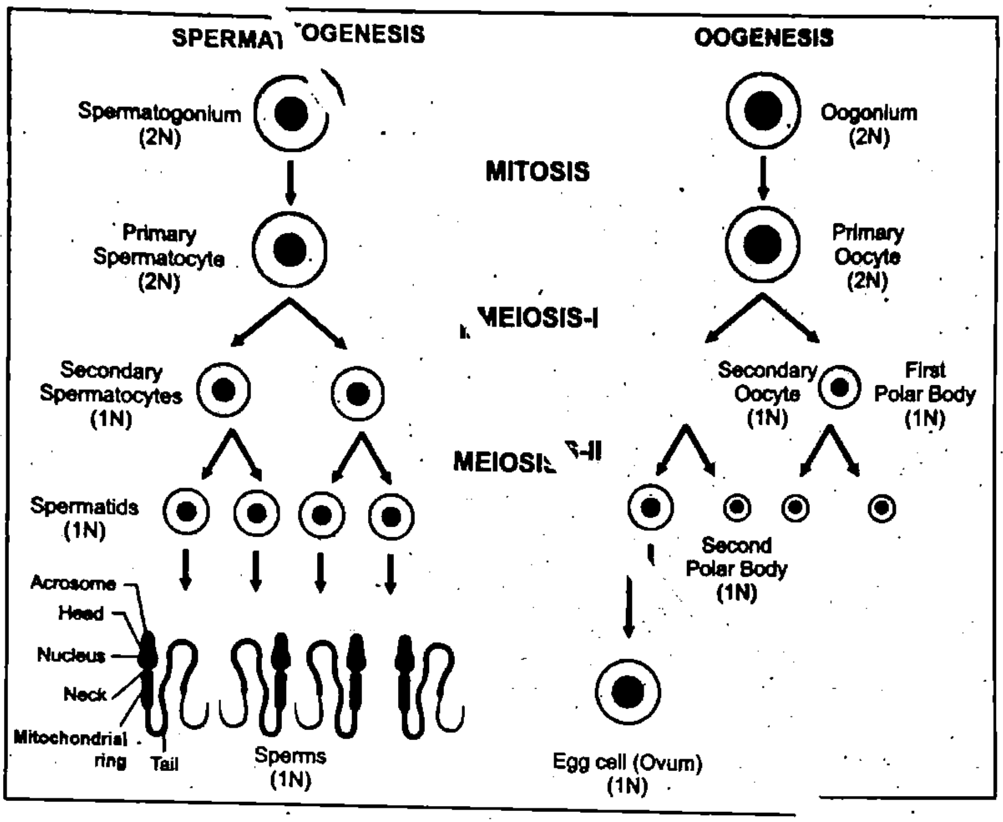


Figure 14.19 Gametogenesis in Animals

Q.12 Define fertilization and explain its types.

Ans. Fertilization

After the formation of gametes, fertilization occurs. There are two mechanisms by which fertilization can take place:

(1) External fertilization

Introduction

In external fertilization, egg cells are fertilized outside the body.

Explanation

It occurs in aquatic environment and both the male and female animals release their gametes into their surroundings at almost the same time. In external fertilization, there is risk of loss of gametes due to environmental hazards such as predators.

Examples

It occurs in many invertebrates and the first two groups of vertebrates i.e. fishes and amphibians.



Figure 14.20: External Fertilization in Fish

Internal fertilization

Introduction

Egg cells are fertilized within the reproductive tract of female.

Explanation

Such animals provide protection to the developing embryo. After fertilization, reptiles and birds make protective shells around their egg cells and then lay these eggs. Extra protection is provided to embryo and mother supplies all that embryo needs. In mammals, the development of fertilized egg into new body takes place within the mother's body.

Examples

Examples are reptiles, birds and mammals.



Figure 14.21: Reptiles and bird's egg provided protection and Food to Embryo

Q.13 Explain reproduction in Rabbit.

Ans. Rabbits are small mammals found in several parts of the world.

Male reproductive system

The male reproductive system of rabbit consists of:

i) A pair of testes
ii) Associated ducts
iii) Glands

Testes produce sperms, ducts transport these sperms to external genitalia and glands add secretions to sperms.

(1) Testes

They are located in a bag of skin called scrotum. Each testis consists of coiled tubes called seminiferous tubules. Sperms are formed in these tubules.

(2) Associated ducts

Epididimys: When sperms are mature, they accumulate in the collecting ducts of testes and then pass to epididimys.

Vas Deferens

From epididimys, sperms move to a sperm duct called vas deferens.

Both sperm ducts join urethra just below urinary bladder and it transports both sperm and urine.

Semen

Semen is the material containing 10% sperms and 90% fluid.

(3) Glands

As sperm pass down the ducts from testes to urethra, associated glands add various secretions.

i) **Prostate Gland:** It produces a secretion to neutralize the acidity of fluid.

ii) **Cowper's Gland:** It produces secretions that lubricate the ducts.

iii) **Seminal Vesicles:** They produce secretions that provide nutrients for sperms.

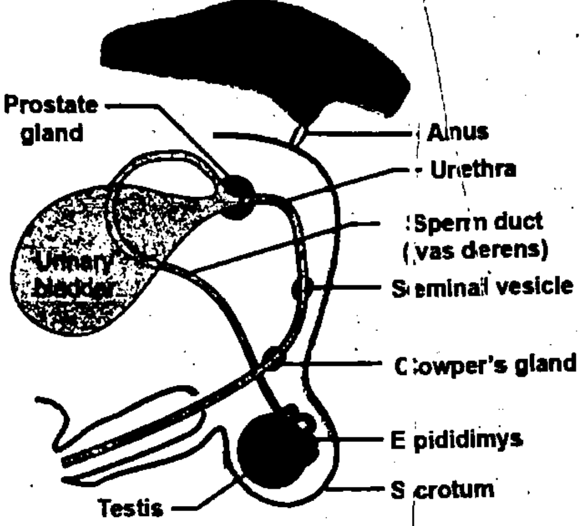


Figure 14.22: Male Reproductive System of Rabbit

Female reproductive system **(Board 2014)**

It consists of:

(i) Ovaries

(ii) Associated ducts.

(i) Ovaries

a. Definition

Ovaries are small oval organs situated in the abdominal cavity just ventral to kidneys.

b. Egg Cells

The outer region of ovary produces egg cells.

c. Follicles

The specialized cells called follicles surrounds and nourishes each egg cell.

(ii) Associated ducts

a. Fallopian tube

From ovaries, egg cells are released into fallopian tubes

b. Uterus

Fertilization occurs in fallopian tubes and the fertilized egg is carried to uterus.

c. Uterus horns

The uterus is divided into two parts or horns..

d. Birth canal

The horns join and open into vagina or birth canal.

e. Cervix

Cervix is the portion of uterus where sperms of male are deposited.

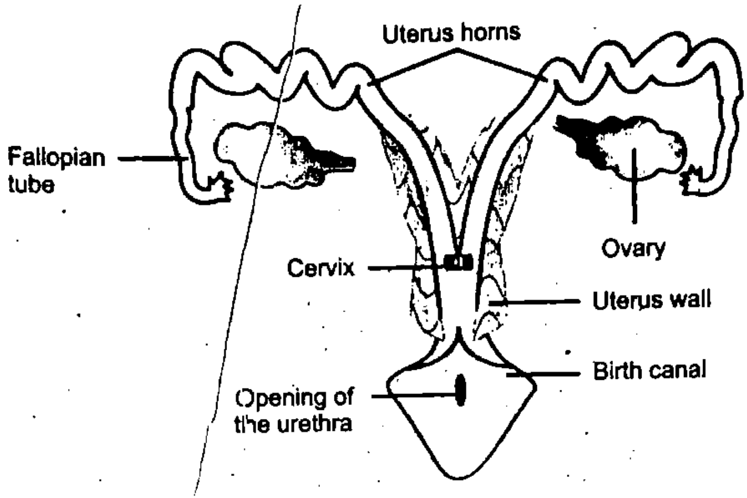


Figure 14.23: Female Reproductive System of Rabbit

Fertilization and development

Rabbit can breed throughout the year but male rabbits are commonly sterile during the summer months. Male rabbit deposits its sperms into female vagina. Sperms swim through cervix and uterus to fallopian tubes where they fertilize the egg cells.

Embryo

Zygote is carried to uterus where zygote started dividing and is now called embryo. Embryo is implanted in uterus walls.

Placenta

A connection called placenta is established between embryo and uterus wall.

Development of new Offspring

Embryo develops into a new offspring in 30-32 days after which it is born.

Q.14 Describe Growth in Human population and its consequence.

Ans: Pakistan's Population

Pakistan's population in the year 2007-08 was 163,775,000. By the end of this decade, our population is expected to exceed 176 million.

High growth rate in past

Pakistan's population had relatively high growth rate in past. When population exceeds the carrying capacity of an area, it results in overpopulation.

Problems with human overpopulation

(i) Shortage of Fresh Water
(ii) Deforestation and loss of ecosystem.
(iii) More population and global warming
(iv) High infant and child mortality rate due to poverty.
(v) Shortage of housing units, hospitals, jobs, educational institutions and food.

Preventive measures to control population

(i) People should be educated about the problems of overpopulation.
(ii) Pakistan's Ministry of Population Welfare has taken a number of steps to make people aware of the hazards of overpopulation and to stabilize the population to match our resources.



Logo of an organization working for awareness of overpopulation

The United Nations Population Fund
UNFPA began operations in 1969. It is the largest international organization funding for population and health programmes. The UNFPA works in over 140 countries, for awareness about the consequences of overpopulation.

Q15. Explain the social implications of AIDS and other Sexually Transmitted Diseases. (STD's).

Ans. AIDS

AIDS is a sexually transmitted disease and transmitted through sexual act. AIDS stands for Acquired Immuno Deficiency Syndrome. It is caused by Human Immuno Deficiency Virus (HIV). The virus destroys white blood cells which results in the loss of resistance against infections. It is a fatal disease.

Spreading

It spreads through transfer of body fluid such as blood and semen.

Cause: Main causes are:

i) Unprotected sexual activities.

ii) Use of infected needles.

iii) Transfusion of infected needles.

Role of National AID control programme (NACP) and Non-Government organizations (NGOs)

Pakistan Federal Ministry of health established NACP in 1987. The main objective of this programme is to help the public for the prevention of HIV transmission. The frequency of HIV infection in Pakistan is low but still at risk.

For improvement, NACP started services through TV and radio channels and print media in 2005. The objective are:

- Change public attitude for safe sexual activities.
- Create demand for information on HIV and AIDS
- Improve attitudes and behaviour among health care workers.

Unit 15

Inheritance

Long Answer Questions

Q.1 Define the following terms:
Genetics, inheritance, traits and genes

Ans.

Genetics

It is a branch of biology in which we study inheritance.

OR

The branch of biology which describes that how traits and characteristics are transferred from parents to offspring is called genetics.

Inheritance

It means the transmission of characteristics from parents to offspring.

Traits

Characteristics which are transmitted from parents to offspring are called traits. e.g., in man height, colour of the eyes, intelligence etc.

Genes

The chromosomes carry the biological units of inheritance called the genes.

Q.2 What are chromosomes and genes. Describe the structure of chromosomes.

Ans. Genes

Genes consist of DNA. They contain specific instructions for protein synthesis.

Units of inheritance, located on chromosomes are called genes.

Chromosomes

(a) Introduction

Hereditary material found in the nucleus of every cell is called chromosomes.

(b) Constant number

Body cells have a constant number of paired chromosomes.

(c) Homologous chromosomes

The two chromosomes of a pair are known as homologous chromosomes. In human body cells, there are 23 pairs for a total of 46 chromosomes.

(d) Chemical composition

They are made of chromatin material (chromatin). Chromatin is a complex material, made of DNA and proteins (histone).

(e) Nucleosomes

DNA wraps around histone proteins and forms round structures, called nucleosomes. DNA is also present between nucleosomes.

Beads on a string

The nucleosomes and the DNA between them look like beads on a string.

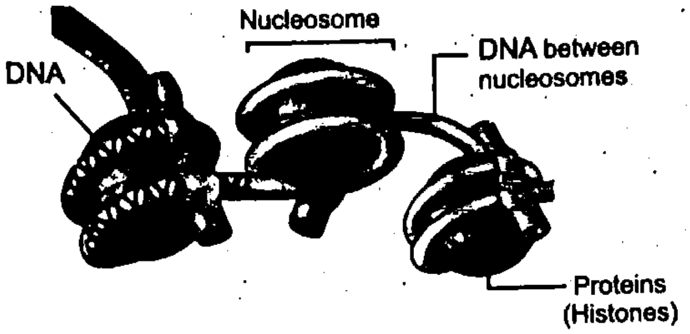


Figure 15.1: Chemical composition of chromosome

Chromosomes

The fibers consisting of nucleosomes condenses into compact forms and get the structure of chromosomes.

Q.3 Describe structure of DNA.

Ans. James Watson and Francis Crick

In 1953, James Watson and Francis Crick proposed structure for DNA.

Double Helix

According to Watson-Crick model, a DNA molecule consists of two polynucleotide strands which are coiled around each other in the form of double helix.

Sugar-phosphate Backbone

There is phosphate-sugar backbone on the outside of double helix.

Nitrogenous Bases

Nitrogenous Bases are present on the inside of double helix.

Base Pairing

In double helix, the nitrogenous bases of opposite nucleotides form pairs through hydrogen bonds.

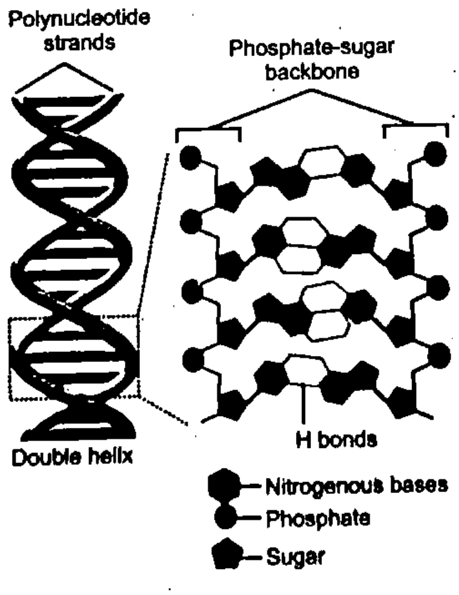


Figure 15.2: The Watson and Crick model of DNA

Specificity in Base pairing

Pairing is very specific. The nitrogenous base Adenine of one nucleotide forms pair with Thymine of opposing nucleotide while Cytosine forms pair with Guanine.

Hydrogen Bonding

There are two hydrogen bonds between Adenine and Thymine while there are three hydrogen bonds between Cytocine and Guanine.

Q.4 Describe DNA Replication.

Ans. Definition

It is a process in which one parental DNA is divided into two genetically identical daughter DNA molecules. DNA replication takes place before cell division.

Purpose

It is done to make the copies of chromatids of chromosomes.

Unwinding of DNA strands

First step in DNA replication is unwinding of DNA. As a result, two strands are separated, much like two sides of zipper.

Template strands

Each strand of parental DNA acts as a template.

Complimentary strands

New strands are called as complimentary strands.

Base pairing

Nitrogenous bases of nucleotides in template strands make pair with nitrogenous bases of nucleotides in complimentary strands.

New (Daughter) DNA Double helix

One template and one complimentary strands together form a new DNA double helix, genetically identical to parents.

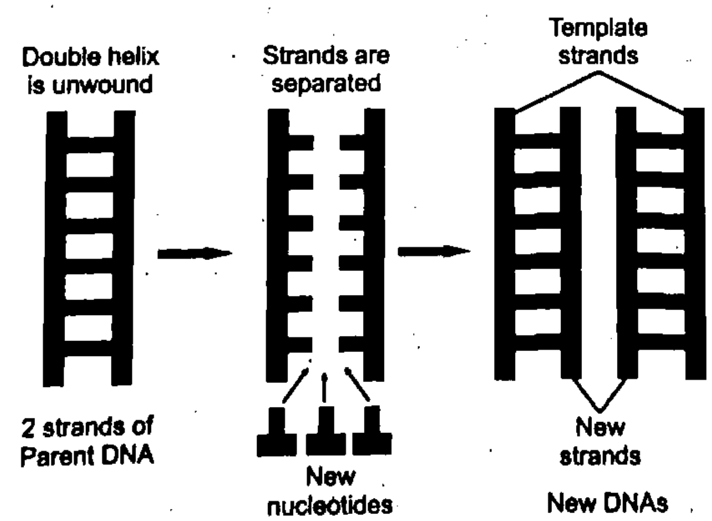


Figure 15.3: How does DNA replicate?

Q.5 How does DNA of chromosome work? **(Board 2014)**

Ans: DNA

DNA is the genetic material. It performs its role by giving instructions for synthesis of specific proteins. Cell is actually controlled by its DNA. It is the DNA which makes characteristics or traits of cell or organism.

Roles of proteins

Proteins may have different roles. Some perform structural roles e.g. Keratin while other acts as enzymes to control all bio-chemical reactions of cells.

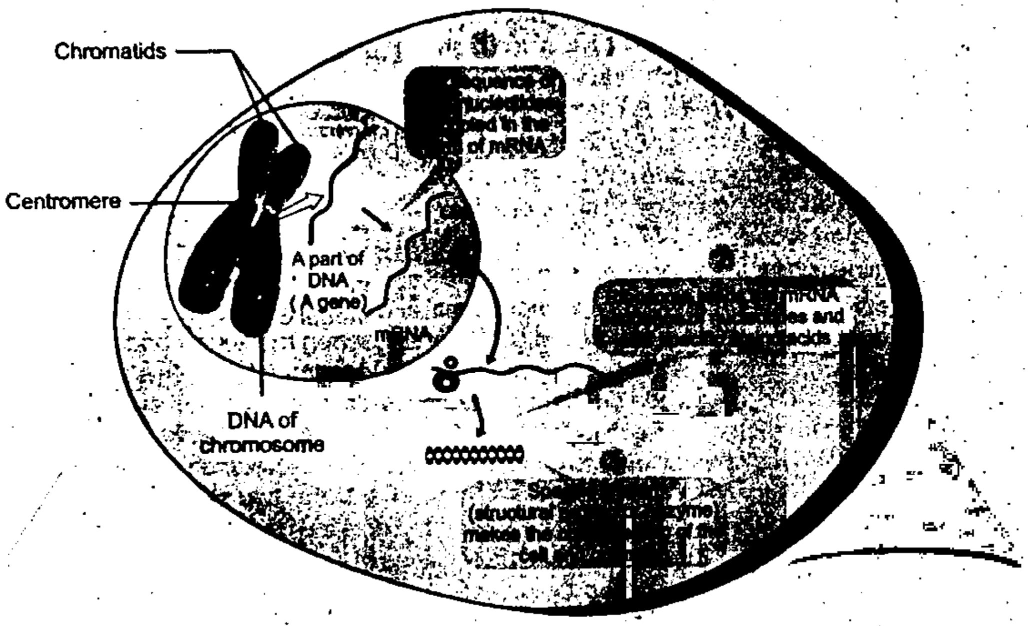


Figure 15.4: Working of DNA (also called the central Dogma)

Traits

Traits are made by specific proteins.

Sequence of Amino acids

Sequence of amino acids is controlled by specific sequence of nucleotides in DNA.

Protein Synthesis

Protein synthesis takes place in two steps:

(i) Transcription (ii) Translation

Transcription

It is a process in which specific sequence of DNA nucleotides is copied in the form of messenger RNA (mRNA) nucleotides.

Translation

The mRNA carries sequence of its nucleotides to ribosomes. The ribosome reads this sequence and joins specific amino acids, accordingly to it, to form protein. This is called as translation.

Q.6 Describe role of genes and alleles.

Ans. Gene

The part of DNA (sequence of nucleotides) that contains the instructions for the synthesis of a particular protein is known as a gene.

Gene Loci

DNA of each chromosome contains thousand of genes which are in pairs, one on each homologous chromosome. The locations or positions of genes on chromosomes are known as loci.

Role of Gene

Each gene determines a particular trait in an organism. Each individual carries at least one pair of genes for each trait.

Representation of gene pairs

Pairs of genes are represented by a letter or symbol. Both members of a gene pair may be the same like 'AA' or 'aa' or 'BB' and different in others like 'Aa' or 'Bb'. It means that a gene exists in more than one alternate forms of genes.

Alleles

The alternate forms of a gene are called alleles. If an individual has 'Aa' gene pair, 'A' and 'a" are the alleles of one another. Both alleles are located on the one member separately of the homologous pair.

Separation of Alleles

When chromosomes separate during meiosis, alleles also separate and each gamete gets one of the two alleles. When gametes of both parents unite, the zygote receives one allele from each parent.



Figure 15.5: Location of alleles on chromosomes

Q.7 What is Genotype? Explain its different types. (Board 2013)

Ans: Genotype

The specific combination of genes in an individual is known as the genotype of that individual. It is of two types:-

(i) Homozygous (ii) Heterozygous

(i) Homozygous Genotype

The genotype in which the gene pair contains two identical alleles (AA or aa) is called as homozygous genotype.

(ii) Heterozygous genotype

The genotype in which the gene pair contains two different alleles (Aa) is called as heterozygous genotype.

Explanation with example

Albinism

It is a condition in which normal body pigments are absent. Like other traits, it is also controlled by one pair of genes.

Recessive trait

Albinism is recessive trait i.e., it is produced when both recessive alleles are present in an organism.

Alleles for a trait

Two alleles for a gene pair are represented as 'A' and 'a'. Allele 'A' produces normal body pigments while allele 'a' does not produce pigments.

Three combinations

Three combinations i.e. genotypes are possible for these two alleles.

(i) AA (ii) Aa (ii) aa

Dominant allele

In heterozygous condition one allele masks or prevents the expression of other. It is called as dominant allele and it is represented by capital letter.

Recessive allele

In heterozygous condition, one allele is not expressed, it is called as recessive allele. It is always represented by lower case letters.

Genotype AA or Aa

If genotype is 'AA' or 'Aa', the individual will produce pigments.

Genotype aa

If genotype is 'aa', no pigments will be produced and individual will be albino.

Conclusion

So it is concluded that allele 'A' dominates allele 'a' because in 'Aa' individual pigments are produced and the effect of 'a' is suppressed by 'A'.

Phenotype

The expression of genotype in the form of trait (in albinism, being albino or having normal pigmentation) is known as phenotype.

Q.8 What do you know about Gregor Mendel? Why he selected pea plant for his genetic experiments?

Ans: Gregor Mendel

Gregor Mendel was monk (priest) in Austria. He developed the fundamental principles of genetics.

Special factors

Mendel proposed that there are "special factors" in organisms which control expression of traits and their transmission to next generations. These factors were eventually termed as genes.



Mendel used 28,000 pea plants in his experiments.

Pea Plant (*Pisum sativum*)

Mendel selected pea plant to carry out large number of genetic experiments. He argued that an organism for genetic experiments should have the following features:

1. There should be a number of different traits that can be studied.
2. The organism should have contrasting traits e.g. for the trait of height there should be only two very different phenotypes i.e. tallness and dwarfness.
3. The organism (if it is a plant) should be self-fertilizing but cross fertilization should also be possible.
4. The organism should have short but fast life cycle.

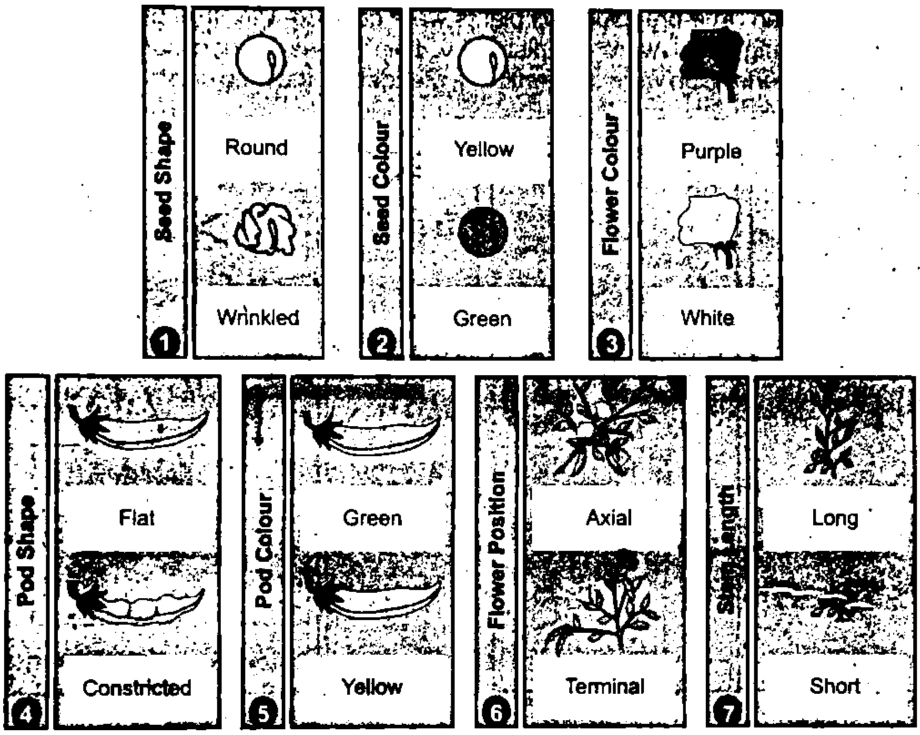


Figure 15.6: Traits in pea plant studied by Mendel

Cross pollination can also be done by transferring the pollen grains from the flower on one plant to the flower on another plant. Each trait studied in pea plant had two distinct forms.

Q.9 Define and Explain Mendel's law of segregation.

Ans: Definition

In each organism, genes are present in pairs. During gamete formation the genes (alleles) of each pair segregate from each other and each gamete receives one gene from the pair. When gametes of male and female parents unite, the resulting offspring again gets the genes in pairs. This is called as Mendel's law of segregation.

Explanation

Seed shape

Mendel studied the inheritance of seed shape first. Seed shape is a trait, like other traits in pea plant, which has two distinct forms:

1. Round seed shape
2. Wrinkled seed shape

Monohybrid cross

A cross in which only one trait is studied at a time is called as monohybrid cross.

P1 Generation

The parental generation is denoted as P1 generation. Mendel crossed true breeding round seeded plant with true breeding wrinkled seeded plant.

F1 Generation

The offspring of P1 generation are called as F1 generation (first filial).

Dominant trait

The trait which appear in F1 generation is called as dominant trait.

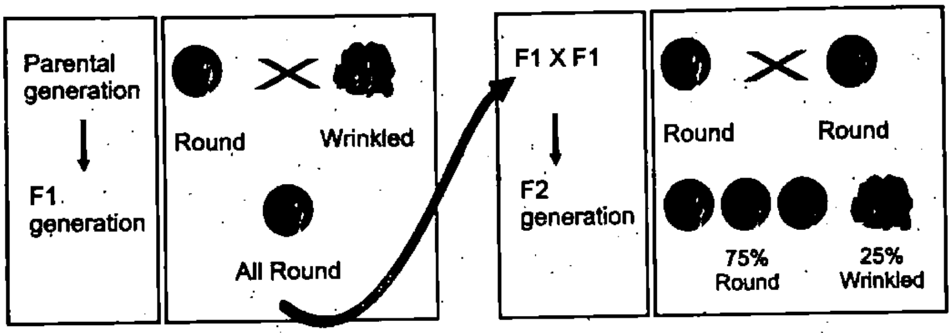
Recessive trait

The trait which does not appear in F1 generation is called as recessive trait.

So Mendel declared the trait round seeds as dominant while wrinkled seeds as recessive trait.

Self-fertilization / F2 Generation

The offspring of P1 generation are called as F1 generation. Later on, Mendel planted F1 seeds and allowed new plants to self-fertilize. As a result, he got 7324 seeds out of which 5474 round and 1850 wrinkled.



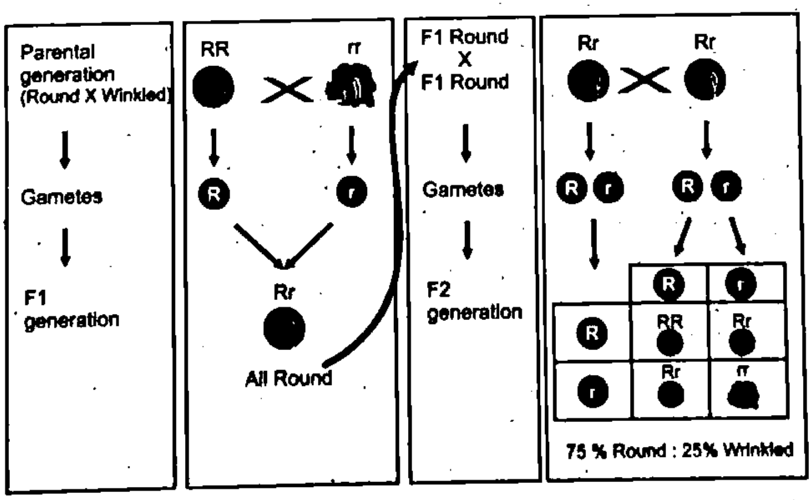
Phenotypic Ratio

In F2 seeds, phenotypic ratio would be 3 round: 1 wrinkled

Height

Mendel also studied inheritance of height in pea plant and he got same results.

When true breeding tall plants were crossed with true breeding short plants, all offsprings of F1 generation were tall i.e. Tallness is dominant trait. When members of F1 generation were-self-fertilized, Mendel got ratio of tall to short plants in F2 as 3:1.



Discrete factors

Mendel concluded that the traits under study were controlled by discrete factors which are no called as genes.

Q.10 Define and Explain Mendel's Law of Independent Assortment. (Board 2013)

Ans: Definition

Alleles of a gene pair segregate (get separated and distributed to gametes) independently from the alleles of other gene pair. This is called as law of independent assortment.

Dihybrid Cross

It is a cross in which two contrasting traits are studied at a time.

In next crosses, Mendel studied dihybrid crosses.

Traits

Traits under study were as follows:-

Seed shape

It has two distinct forms:-

(a) Round
(b) Wrinkled

Seed Colour

It has also two distinct forms:-

(a) Yellow
(b) Green

Dominance

The trait of round seed was dominant over wrinkled, similarly yellow seed colour was dominant over green.

Alleles controlling traits

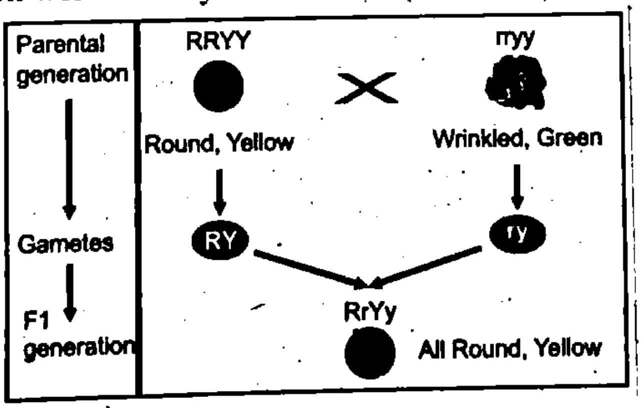
Round seed shape is controlled by 'R' and wrinkled by 'r', similarly yellow seed colour is controlled by 'Y' and green by 'y'.

P1 Generation

Mendel crossed the true breeding plant that had Round yellow seeds with true breeding wrinkled green seeds.

F1 Generation

All seeds in F1 generation were round yellow.

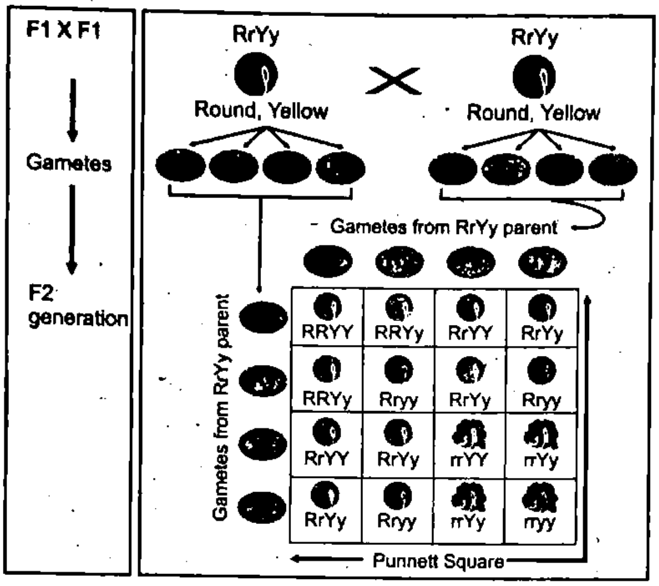


F2 generation

When F1 seeds grow into plants they were self fertilized. This cross produced seeds with four phenotypes. There were 315 round yellow seeds, 108 round green seeds, 101 wrinkled yellow seeds and 32 wrinkled green seeds.

Ratio in F2 Generation

The ratio of these phenotypes was 9:3:3:1.



"The Punnett square is a diagram that is used to predict an outcome of a particular cross or breeding experiment. It is named after R.C. Punnett (an English mathematician). The gametes of both parents having all possible genetic set-ups are determined. A checker board is used to cross all the possible gametes of one parent with all the gametes of other parent. In this way, a biologist can find all the possible genotypes of offspring.

Conclusion

Mendel explained that two traits i.e., seed shape and seed colour are not tied with each other. The segregation of 'R' and 'r' alleles happens independently of segregation of 'Y' and 'y' alleles.

Q.11 Define and explain co-dominance and Incomplete dominance with examples.

Ans. Co-dominance

It is a situation where two different alleles of a gene pair express themselves completely instead of showing dominant-recessive relationship. As a result, heterozygous organism shows phenotype that is different from both homozygous parents.

Example

ABO Blood Group

Gene I

The ABO blood group system is controlled by gene I.

Alleles

Gene I has three alleles:-

(a) I^A

(b) I^B

(c) i

Allele I^A

Allele I^A produces antigen A in blood and the phenotype is blood group A.

Allele I^B

Allele I^B produces antigen B in blood and phenotype is blood group B.

Genotype	Antigen produced	Phenotype	Relationship between alleles
I^AI^A or I^Ai	Antigen A	Blood group A	Allele I^A is dominant over i
I^BI^B or I^Bi	Antigen B	Blood group B	Allele I^B is dominant over i
ii	No Antigen	Blood group O	Allele I is recessive
I^AI^B	Antigen A & Antigen B	Blood group AB	Alleles I^A and I^B are co-dominant

Allele i

Allele i does not produce any antigen and the phenotype is blood group O.

Complete Dominance

Allele I^A and I^B are completely dominant over allele *i*.

Genotype I^A I^B

In heterozygous genotype I^A I^B, each of the two alleles produces the respective antigens and neither of them dominates over the other. So blood group will be AB.

Incomplete Dominance

It is a situation where in heterozygous genotypes, both the alleles express as a blend (mixture) and neither allele is dominant over the other. As a result of this blending, an intermediate phenotype is expressed.

In Four O Clock plants, the 3 flower colours are red, pink and white. There is no specific gene responsible for producing pink flowers.



Four O Clock plant

Flower colour

The trait of flower colour is controlled by two alleles i.e. 'R' and 'r'.

Allele 'R'

Allele 'R' is responsible for giving red colour to flower.

Allele 'r'

Allele 'r' is responsible for giving white colour to flowers.

True Breeding Plants

True breeding plants 'RR' and 'rr' have red and white coloured flowers respectively.

Heterozygous plants of F1 Generation

When homozygous red flowered plant (RR) is crossed with homozygous white flowered plant (rr), the heterozygous (Rr) plants of F1 generation produce pink flowers.

Blending

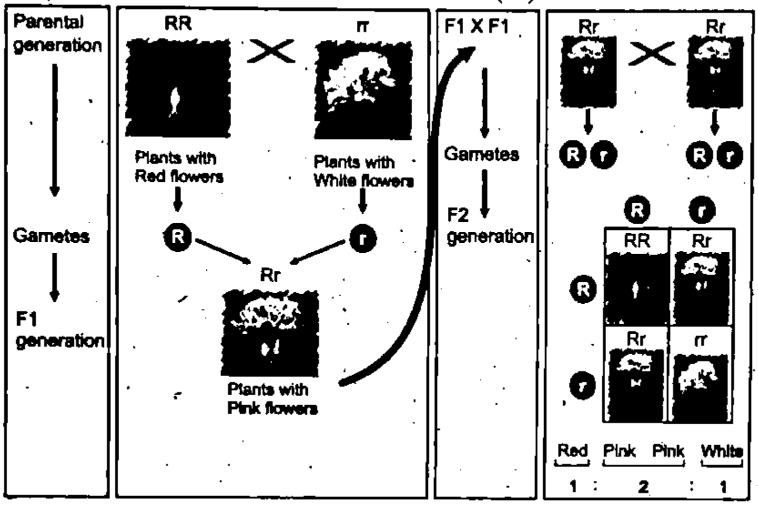
Pink colour is blend of red and white colours.

F2 Generation

When two heterozygous plants with pink flowers (Rr) are crossed, F2 generation shows phenotype of red, pink and white flowers in the ratio 1:2:1.

Conclusion

Thus, it is concluded that neither of red flower allele (R) and white flower allele (r) is dominant.



Q.12 Define variations. Discuss their sources and types.

Ans. Definition

Differences shown by the individual of same species are called as variations.

Sources of variations

(a) Genetic Recombination

The genetic recombination produced through crossing over results in gametes with variations.

(b) Mutation

Mutation (changes in DNA) are important source of variations.

(c) Combination of Sperm with egg

During fertilization, one of the millions of sperms combines with a single egg. The chance involved in this combination also act as the source of variations.

(d) Gene Flow

Movement of genes from one population to another is also an important source of variations.

(e) Combination of Chromosomes

Variations are also caused by different combinations of chromosomes in gametes and then in zygote.

Types of Variations

(i) Continuous variations

In continuous variations, the phenotypes show a complete range of measurements from one extreme to the other.

Such variations are controlled by many genes and also affected by environmental factors.

Examples

Height in Man
Weight in Man
Feet size in Man
Intelligence in Man

Height in Man

In every human population, the individuals have range of heights (from very small to tall). No population can show only two or three distinct heights.

(ii) Discontinuous variations

Discontinuous variations show distinct phenotypes. The phenotypes of such variations cannot be measured. The individuals of population have distinct phenotypes which can easily be distinguished from each other.

Discontinuous variations are controlled by the allele of a single gene pair. Environment has no effect on such variations.

Example

Blood groups in Man

In human population, an individual has one of the four distinct phenotypes (blood groups) and cannot have in between.

Q.13 What is Biological or Organic Evolution? Explain with the help of Darwin's theory of natural selection.

Ans: Biological/Organic Evolution

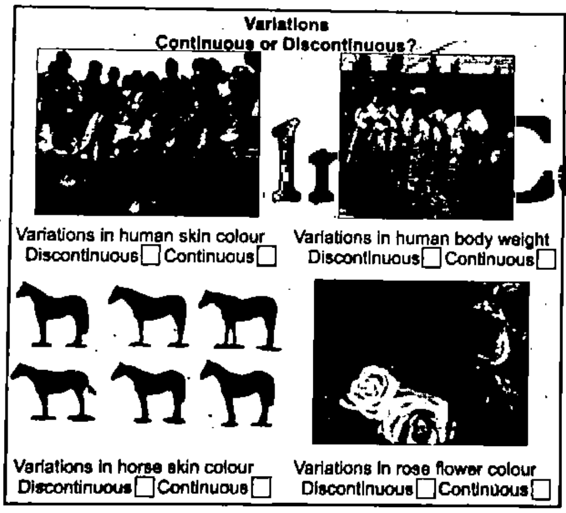
It is a change in the characteristics of a population or species of organisms over the course of generations.

The changes in an individual are not considered as evolution because evolution refers to populations and not to individuals.

Processes

Organic evolution includes two major processes:-

- Alteration in genetic characteristics (traits) of a type of organism over time.
- Creation of new types of organisms from a single type.




Buffon


Lamarck

French biologist C. de Buffon (1707–1788) was the first to hint at evolution. His countryman J. de Lamarck (1744–1829) was the first to propose a mechanism of evolution. Lamarck's ideas were soon rejected due to the vagueness of the mechanisms he proposed.

Theory of Natural Selection

Charles Darwin (1809 – 1882) proposed the mechanism of organic evolution in 1838. It was called as "The theory of natural selection". "Darwin proposed after his 5-year voyage on HMS (His Majesty's Ship) Beagle. He also published a book "On the Origin of Species by means of Natural Selection" in 1859.

Early response to Darwin's theory

Darwin theory of evolution was not widely accepted because of lack of sufficient evidence. Modern evolutionary theory began in the late 1920's and early 1930s.

Some scientists proved that the theory of natural selection and Mendelian genetics are the same ideas just as Darwin has proposed.

Importance of study of evolution

It determines the ancestry and relationships among different kinds of organisms.

Theory of special creation

The anti-evolution ideas support that all living things had been created in their current form only a few thousand years ago. It is known as the "theory of special creation."

MECHANISM OF EVOLUTION

Natural selection

It is a process by which the better genetic variations become more common in successive generations of a population.

Variations in population

Almost every population contains several variations for the characteristics of its members. These variations are of two types:

(i) Morphological Variations
(ii) Physiological Variations

Evolutionary Fitness of Organism

The central concept of Natural selection is the evolutionary fitness of an organism.

Fitness means an organism's ability to survive and reproduce. Organisms produce more offspring than can survive and these offspring vary in fitness.

Struggle for survival

These conditions produce struggle for survival among the organisms of a population.

Favourable variations

The Organisms with favourable variations are able to reproduce and pass these variations to their next generations.

Unfavourable Variations

On the other hand, rate of the transmission of unfavourable variations to next generations is low. It means that unfavourable variations are selected against their transmission to next generations.

Examples

Skin colour in Mouse

There are three variations in skin colour of mouse population:-

- Light coloured
- Medium coloured
- Dark coloured

Cat preys upon light and medium coloured mouse.

First Generation

In first generation, light coloured mouse is preyed upon by cat. Only medium and dark coloured mouse can make their next generations.

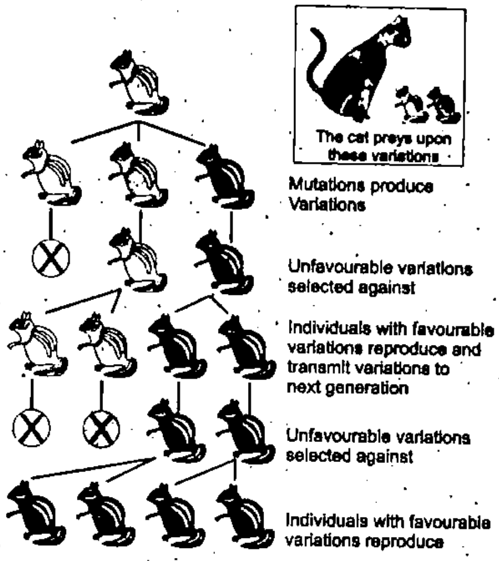


Figure 15.7: The concept of natural selection

Next Generation

In next generation, population again contains light, medium and dark coloured mouse. Cat preys upon the light and medium coloured mouse. Now only dark coloured mouse make new generation.

Favourable Variations

It happens in many generations, we will see only the dark coloured mouse in the population.

Natural selection

As a result of natural selection, the alleles that give more fitness of characteristics (favourable variations) than other alleles become more common within population.

Colour Variations in Moth

In England, moths had two variations i.e.,

(i) Dark coloured moth
(ii) White coloured moth

Light coloured tree trunk

The moths used to rest on the light coloured tree trunks (on which white lichens had grown).

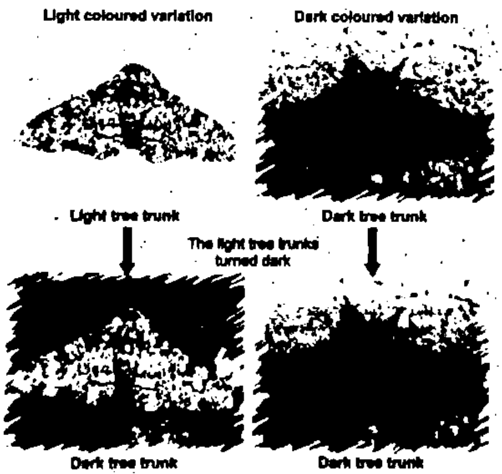


Figure 15.8: White and dark coloured moths

Favourable variations

In those days, light colour was favourable variation as they were invisible to predatory birds while resting on light coloured tree trunks.

Industrial Revolution

After industrial revolution in England, the lichens on tree trunks died due to polluted air and naked tree trunks turned dark.

The Unfavourable variation

Now the white moth variation became unfavourable or harmful because a white moth resting on dark tree trunk was easily visible to predatory birds.

Natural Selection

The natural selection selected dark moths to reproduce. In this way, dark coloured moth became more common and at last white moths disappeared from population. In this case, the dark colour variation in moth may be considered an adaptation to environment.

Conclusion

So it is concluded that individuals with favourable variations become major part of population while individuals with harmful or unfavourable variations become rare.

Q.14 What is artificial selection? Explain it. (Board 2014)

Ans. Definition

Artificial selection (or selective breeding) means intentional breeding between individuals for certain traits or combination of traits.

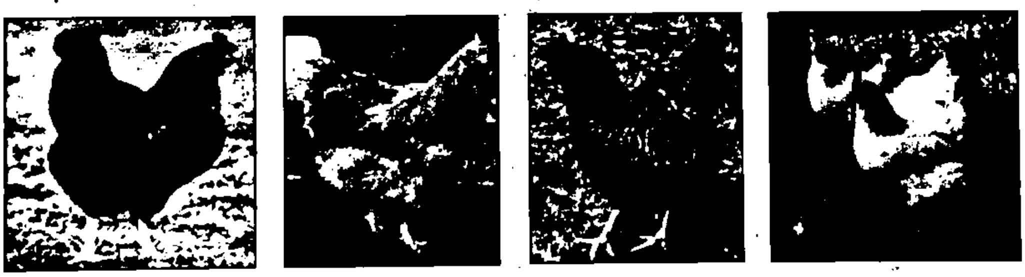


Figure 15.9: Breeds of hen produced through artificial selection

Historical Background

(a) Abu Rayhan Biruni

The term artificial selection was expressed by the Persian scientist Abu Rayhan Biruni in the 11th century.

(b) Charles Darwin

Charles Darwin also used this term in his work on natural selection. He noted that many domesticated animals and plants had special properties that were developed by:

- Intentional breeding among individuals with desirable characteristics;
- Discouraging the breeding of individuals with less desirable characteristics.

Desirable characteristics

Animals or plants having desirable characteristics are selected for breeding. In this way, many new generations with desirable characteristics are produced.

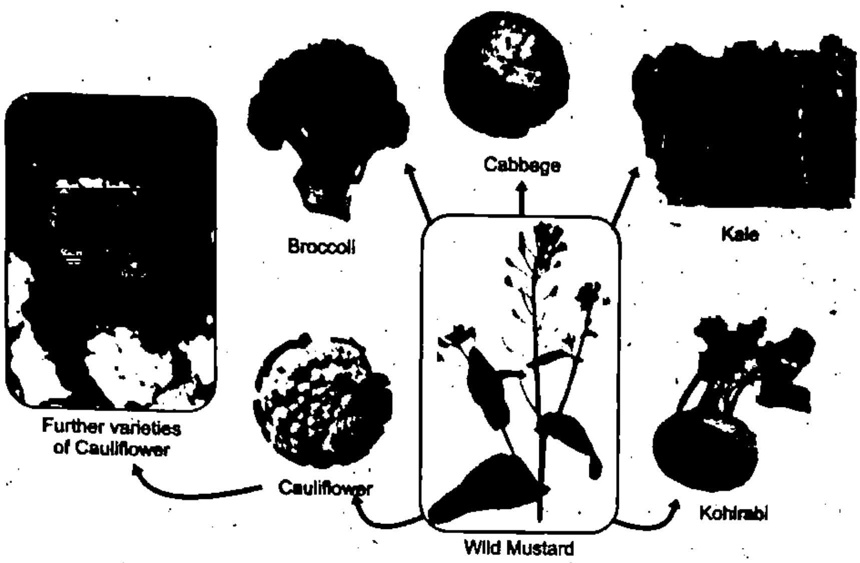


Figure 15.10: Plant varieties produced through artificial selection in wild mustard

Breeds

In artificial selection, the bred animals are known as breeds.

Varieties or Cultivars

In artificial selection, bred plants are known as varieties or cultivars.

Examples

(i) Numerous breeds of sheep, goat, cow, hen etc have been produced by artificial selection to increase the production of wool, meat, milk, eggs etc.

(ii) Similarly, varieties of plants have been produced for better quantity and quality of cereals, fruits and vegetables.

Unit 16

Man and His Environment

Long Answer Questions

Q.1 Define environment and ecology.

Ans: Environment

An environment is the sum of physical (abiotic) and biological (biotic) components which influence that organism.

Ecology

The study of the interrelationship between living organisms and their environment is called ecology. **Or** The study of the interaction of organisms with their environment.

Q. 2 Explain Levels of Ecological Organization.

Ans: In ecosystem, the levels of organization range from organism to biosphere. The followings are the levels of ecological organization:-

1. Species

A species is a group of organisms which can interbreed freely in nature to produce fertile offspring.

Examples

Human, Cat, Dog etc.

2. Population

A group of organisms of the same species inhabiting a specific geographical area at a particular time is called population.

Example:- Number of rats in a field.

3) Community

All the populations that live in a habitat and interact in various ways with one another are collectively called a community.

Example

Forest is an example of community.

4) Ecosystem

Living organisms cannot live isolated from the nonliving part of their environment. The biotic (living organisms) and abiotic components (air, water, light, soil etc.) of environment interact with each other to form a stable system. The self-sufficient unit of an environment that is formed as a result of interactions between its biotic community and the abiotic components is called ecosystem.

Examples

i. A pond, a lake and a forest are examples of natural ecosystems.
ii. An aquarium is an example of artificial ecosystem.

5) Biosphere

Definition

All ecosystems of the world together form the biosphere. It includes all the ecosystems of the planet Earth. In other words, the biosphere consists of all organisms present on the earth and all regions of the Earth where they live.

Range

Biosphere ranges from the floor of oceans to the tops of the highest mountains.

Thickness

It is about 20 km thick. The biosphere makes a thin layer surrounding the planet Earth. If you consider the Earth as of the size of an apple, then the biosphere will be as thick as the apple's skin.

Q. 3 Explain Components of Ecosystem.

Ans. An ecosystem is comprised of two basic parts:-

1) Biotic Components **(Board 2014)**

Definition

The living parts (organisms) of the ecosystem is called biotic components.

Examples

- Producers (Plants, Algae and Cyanobacteria)
- Consumers (Animals, Protozoa)
- Decomposers (Bacteria and Fungi)

2) Abiotic Components

The non-living factors present in ecosystem are called abiotic components.

Examples:

i) Air **ii)** Water **iii)** Soil **iv)** Light **v)** Temperature

Biotic Components **(Board 2013)**

1) Producers

Definition

These are the autotrophs in an ecosystem. These organisms are able to synthesize complex organic compounds (food) from inorganic raw materials. Producers form the basis of any ecosystem.

Examples

(i) In terrestrial ecosystems, plants are the main producers.

(ii) In aquatic ecosystems, the main producers are the algae (phytoplankton) and Shallow water rooted plants.

2) Consumers

Definition

These are the heterotrophs in an ecosystem. These organisms are unable to synthesize their food and so depend upon producers for food. The animals are the major consumers of all the ecosystems.

Examples

Animals, Fungi, Protozoans and many of the Bacteria.

Types of Consumers

i. Herbivores

These animals feed directly on plants or products of plants. They are also called primary consumers.

Examples

Cattle, deer, rabbit, grasshopper etc.

ii. Carnivores

Those animals that feed upon other animals are called carnivores. The carnivores are of following types:

Types of carnivores

a) Primary carnivores

Those carnivores that feed upon herbivores are called primary carnivores. They are secondary consumers.

Examples

Fox, frog, predatory birds, many fishes and snakes.

b) Secondary carnivores

Those carnivores that feed upon primary carnivores are called secondary carnivores. They are tertiary consumers.

Examples

Wolf and owl etc.

c) Tertiary carnivores

Those carnivores that feed upon secondary carnivores are called tertiary carnivores. They are not eaten by any other animals. So they are also called top carnivores.

Examples

Lion, Tiger etc.

Omnivores

Those consumers that eat animal flesh as well as plants and plant products are called omnivores.

Examples

Human and Crow etc.

3) Decomposers or Reducers

Those organisms that break down the complex organic compounds of dead matter (of plants and animals) into simple compounds. They secrete digestive enzymes into dead and decaying organic matter to digest the organic material. Products of digestion are absorbed for their own use and remaining substances are added to the environment for reuse. The minerals, which are released by decomposers, are used as nutrients by the producers.

Examples

Bacteria and fungi.

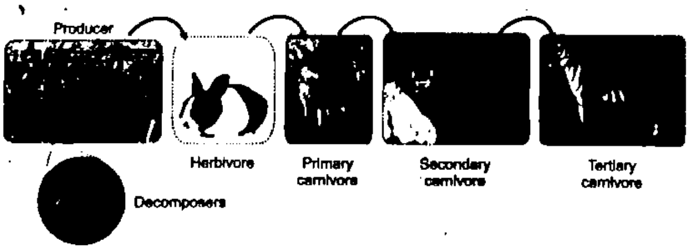


Figure 16.1: Producers, Consumers and Decomposers

Q4 Explain Flow of Energy in an Ecosystem.

Ans. In an ecosystem, energy as well as materials travels from one trophic level to the next.

Trophic Level

Trophic level is the level at which an organism feeds in food chain. The first trophic level is made of producers; the second of primary consumers and so on.

Flow of Energy

The flow of energy in different trophic levels of ecosystem is unidirectional. The following is an overview of the flow of energy in an ecosystem.

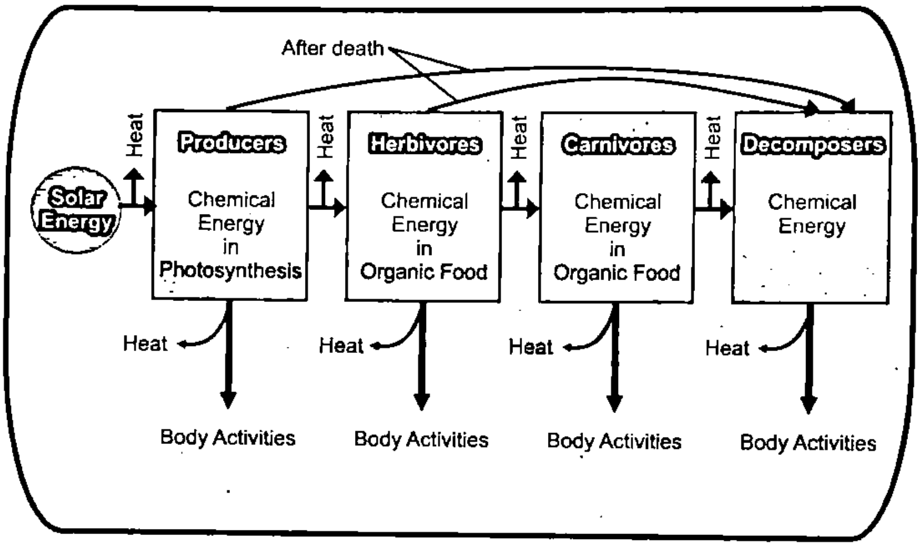


Figure 16.2: Energy flow in an ecosystem

Source of Energy in an Ecosystem

The Sun is the primary source of energy for all ecosystems. Producers get solar energy and transform it into chemical energy by the process of photosynthesis. They store this energy in their tissues and also transform it into mechanical and heat energy during their metabolic activities.

Movement of Energy

The energy in producers' tissues flows to herbivores when producers are eaten. Herbivores transform it into mechanical and heat energy during their metabolic activities and store the rest in their tissues. Carnivores eat herbivores and get energy. They also use it for their body activities and store the rest in their tissues. After the death of producers and consumers, the energy stored in their tissues is used by the decomposers.

Storage and Expenditure of Energy.

The storage and expenditure of energy in an ecosystem is in accordance with the basic law of thermodynamics i.e. "energy can neither be created nor destroyed but can be transformed from one form into another". In an ecosystem there is,

- Constant flow of energy from the Sun through producers to consumers and decomposers.
- A significant decrease in useful energy during transfer of energy at each trophic level.

Q. 5 Explain Flow of Materials in an Ecosystem.

Ans: Introduction

The materials flow from one trophic level to the next by means of food chains and food webs.

Food Chain

A food chain is a series of organisms within an ecosystem, in which each organism feeds on the one before it and is fed by one after it.

Example

Grass ------------ Grasshopper ----------- Sparrow ----------- Hawk

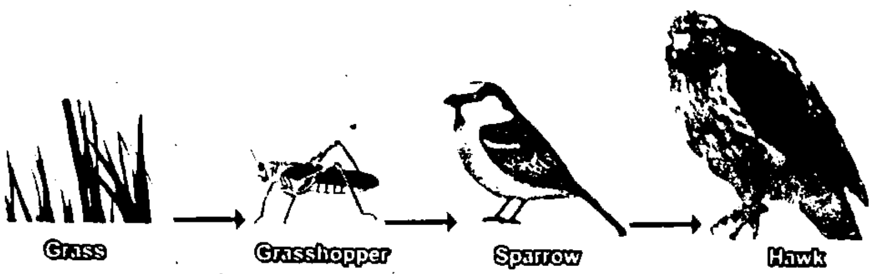


Figure 16.3: A Simple Food Chain

The base of food chain is always formed by a producer. It is eaten by a primary consumer, which is preyed upon by secondary consumer. The secondary consumer may be eaten by a tertiary consumer. A food chain, can therefore, be represented as,

Producer---------- Primary Consumer------------ Secondary Consumer----------- Tertiary Consumer

A food chain involves a nutritive interaction among the biotic components of an ecosystem. Usually there are 4 or 5 trophic levels. Shorter food chains provide greater available energy and vice - versa.

Food Web

In nature, food chains are very complex, as one organism may be the food source of many other organisms. So there is a web like structure formed by these interlinked food chains. Such interconnected food chains collectively make food web. OR

It may also be defined as, "a network of food chains which are interconnected at various trophic levels".

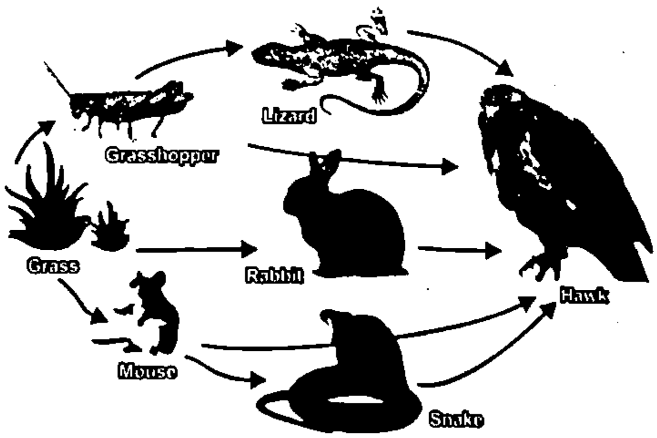


Figure 16.4: A Food Web in Grassland Ecosystem

Q.6 Describe types of Ecological Pyramids. **(Board 2014)**

Ans: Definition

Ecological pyramid can be defined as, "A representation of the number of individuals or amount of biomass or energy present in various trophic levels of a food chain".

Explanation

In 1927, Charles Elton (an English ecologist) developed the concept of ecological pyramids. He noted that the animals present at the beginning of food chain are abundant in number while the animals present at the end of food chain are fewer in number.

Types of Pyramids

Ecological pyramids are of three types:

1) **Pyramid of Numbers**

It is the graphic representation of the number of individuals per unit area at various trophic levels of a food chain.

Example

Usually, producers are present in large number, primary consumers are in lesser number, and secondary consumers are fewer. So, the producers are of smallest size but maximum in number, while the tertiary consumers are larger in size but lesser in number.

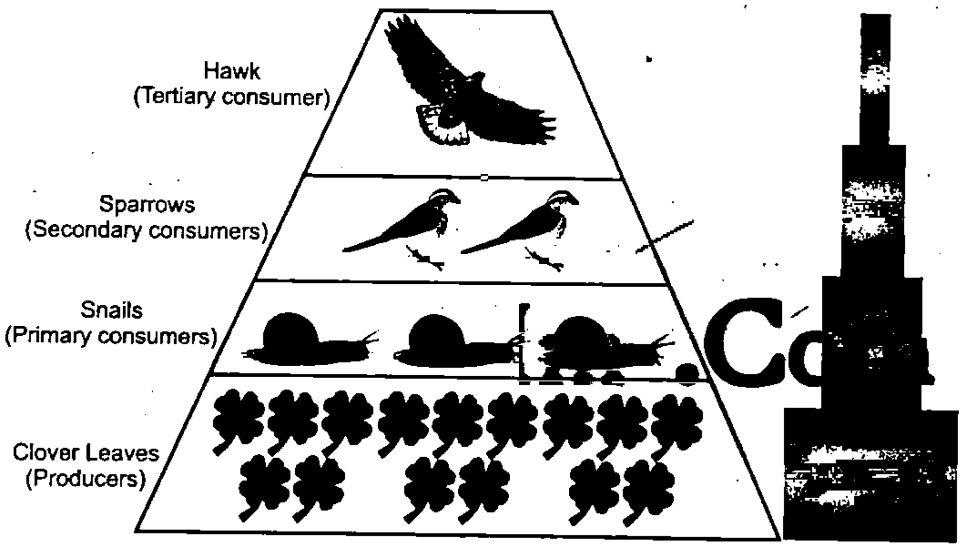


Figure 16.5: Pyramid of Numbers in an Ecosystem

2) **Pyramid of Biomass**

It is the graphic representation of biomass present per unit area at various trophic levels of a food chain.

Example

In a terrestrial ecosystem, the maximum biomass is of producers and there is progressive decrease in biomass from lower to higher trophic levels.

Biomass

The total amount of living or organic matter in an ecosystem at any time is called "biomass".

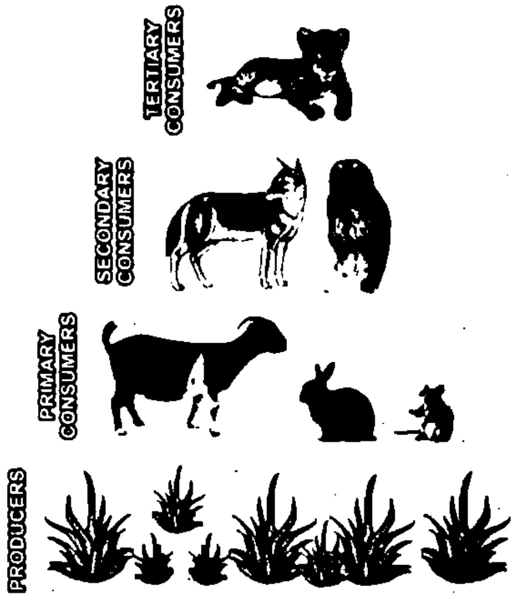


Figure 16.6: Pyramid of Biomass in an Ecosystem

3). Pyramid of Energy

It is a graphic representation of energy present in a biomass of living organisms at various trophic levels of a food chain.

Example

The amount of energy is decreased from producers to decomposers as some amount of energy is used by the organisms to perform work while some of it is lost.

Q. 7 Define biogeochemical cycles. Also explain different cycles in ecosystem.

Ans. Source of bioelements

Environment provides bioelements which are used by organisms for their bodies and metabolism. The materials are continuously recycled between organisms and environment. They are also called nutrient cycles.

Biogeochemical cycles

Biogeochemical cycles are the cyclic pathways through which materials move from environment to organisms and back to the environment.

1. Carbon Cycle

Introduction

Carbon atom is the principal building block of many kinds of biomolecules.

Occurrence of Carbon

Carbon is found as graphite and diamond in nature. It also occurs as carbon dioxide in atmosphere.

Sources of Carbon

Major sources of carbon for the living world are:

- Carbon dioxide present in atmosphere and water.
- Fossil fuels like peat, coal, natural gas and petroleum also contain carbon.
- Carbonates of Earth's crust also give rise to carbon dioxide.

Effects of upsetting of carbon cycle

The balance of carbon cycle has been upset by human activities such as deforestation and excessive burning of fossil fuels. As a result, the amount of carbon dioxide in atmosphere is increasing, causing the green house effect and global warming.

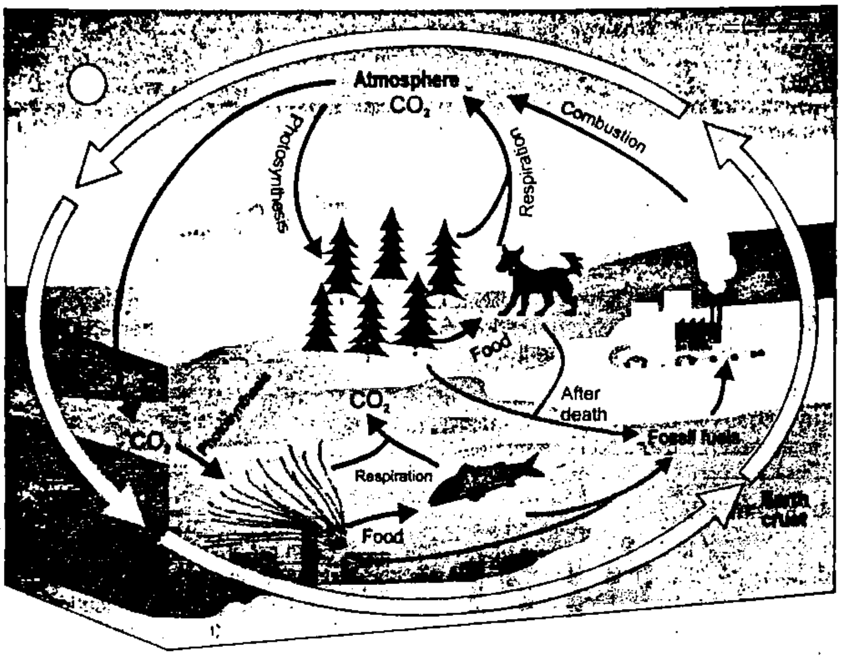


Figure 16.7: Carbon Cycle

Steps of Carbon Cycle

(a) Entry of Carbon into Living Organisms

The major process that brings carbon from the atmosphere or water into living world is photosynthesis.

(b) Transfer of Carbon

Producers take in carbon dioxide from atmosphere and convert it into organic compounds and becomes a part of the body of producers. This carbon enters in food chains and is passed to herbivores, carnivores and decomposers.

(c) Release of Carbon

- Carbon dioxide is released back to environment by respiration of producers and consumers.
- It is also released by the decomposition of organic wastes and dead bodies by decomposers.
- Burning of wood and fossil fuels also add large amount of carbon dioxide into atmosphere.

2) Nitrogen Cycle

Importance of Nitrogen

Nitrogen is an important component of all biomolecules like proteins and nucleic acids (DNA and RNA). These are the most abundant biomolecules in the body of all living organisms.

Unavailability of molecular Nitrogen

Atmosphere is the reservoir of free gaseous nitrogen. Living organisms are unable to use this gaseous nitrogen directly from atmosphere (except for nitrogen fixing bacteria). It has to be converted into nitrates to be utilized by plants.

Steps of Nitrogen Cycle

Nitrogen cycle consists of following steps:

a) **Formation of Nitrates**
b) **Assimilation**
c) **Denitrification**

a) **Formation of Nitrates**

It is done by following ways:

i) **Nitrogen fixation**

Conversion of nitrogen gas into nitrates is called nitrogen fixation. It occurs in the following ways:

- **Atmospheric nitrogen fixation**

Thunderstorms and lightning convert atmospheric gaseous nitrogen into nitrous acid and nitric acid. The acids in turn combine with other salts to produce 'nitrates' this is called atmospheric nitrogen fixation.

- **Biological nitrogen fixation**

Some bacteria also have the ability to transform gaseous nitrogen into nitrates. It is called biological nitrogen fixation. Some of these nitrogen fixing bacteria live as symbionts and many are free living.

- **Industrial nitrogen fixation**

Nitrogen fixation is also done in industries. In industrial nitrogen fixation, hydrogen is combined with atmospheric nitrogen under high pressure and temperature. It produces ammonia which is further converted into ammonium nitrate.

ii) **Ammonification**

Ammonification is the breakdown of proteins of dead organisms and nitrogenous wastes (urea, uric acid etc.) to ammonia. It is done by ammonifying bacteria.

iii) **Nitrification**

After the formation of ammonia, it is converted into nitrites and nitrates. This is called nitrification and is done by nitrifying bacteria. Firstly ammonia is converted into nitrites by bacteria called *Nitrosomonas.* The nitrites are then converted into nitrates by other bacteria called *Nitrobacter.*

b) **Assimilation**

The nitrates when absorbed by plants and utilized for making proteins, nucleic acids etc. Animals take nitrogenous compounds from plants. The utilization of nitrates by organisms is called assimilation.

c) **Denitrification**

It is a biological process in which nitrites and nitrates are reduced to gaseous nitrogen by denitrifying bacteria. In this way nitrogen is returned to the atmosphere.

Effect of excessive denitrification

Excessive denitrification reduces soil fertility and is stimulated by water logging, lack of aeration and accumulation of organic matter in the soil.

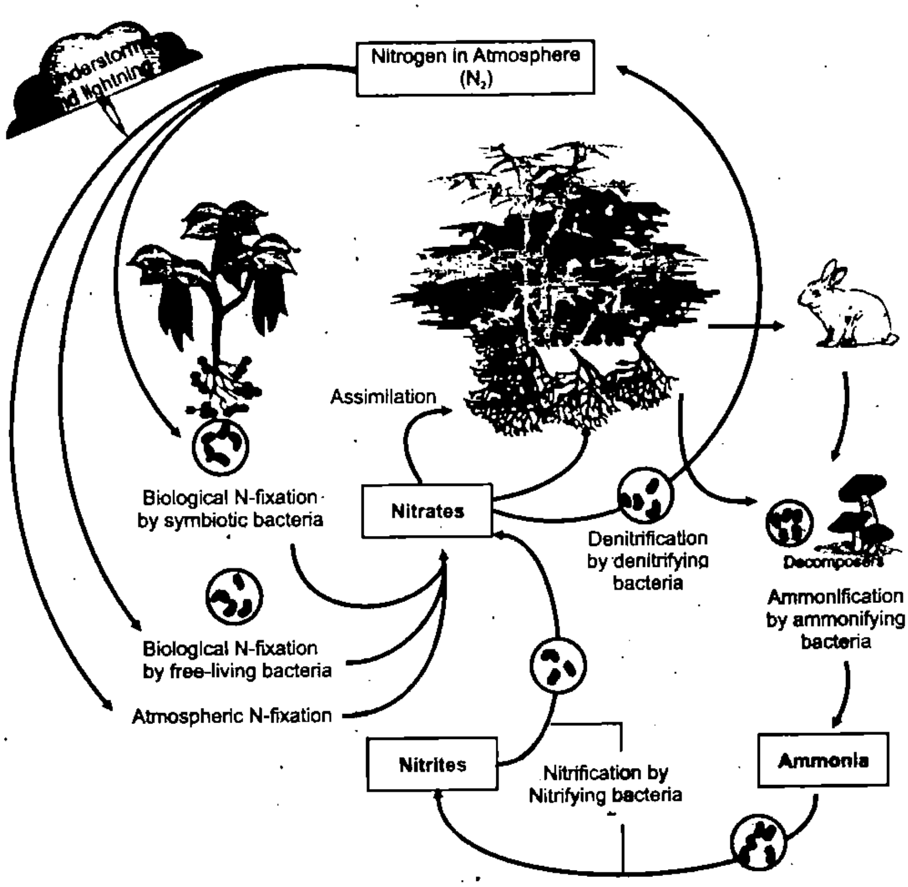


Figure 16.8: Nitrogen Cycle

Q 8 Explain various types of interactions in an ecosystem.

Ans: In all ecosystems, there are many kinds of interaction among living organisms.

(i) Intraspecific interactions

The interactions between the members of the same species are called intraspecific interactions

(ii) Interspecific interactions

The interactions between the members of different species are called interspecific interactions.

Some important interactions among living organisms in ecosystem are given below:

1. Competition 2. Predation 3. Symbiosis

1) Competition

In ecosystems, the natural resources e.g. nutrients, space etc. are usually in short supply. So, there is competition among the organisms of ecosystem for the utilization of resources. The competition may be intraspecific or interspecific.

Intraspecific competition is always stronger and more severe than the interspecific competition. Competition helps in maintaining a balance between the available resources and the number of individuals of a species.

2) Predation

Definition

It is an interaction between two animals of different species or between a plant and an animal. In predation, one organism (the predator) attacks, kills and feeds on other organism (the prey). All carnivore animals are predators. Some examples of predation are given below:-

Examples

1. Frog preys upon mosquito and fox preys upon rabbit. There are some examples where a predator is preyed upon by a second predator and then the second one is preyed upon by a third predator. For example, frog (predator 1) is preyed upon by a snake (predator 2) and the snake is preyed upon by an eagle (Predator 3).

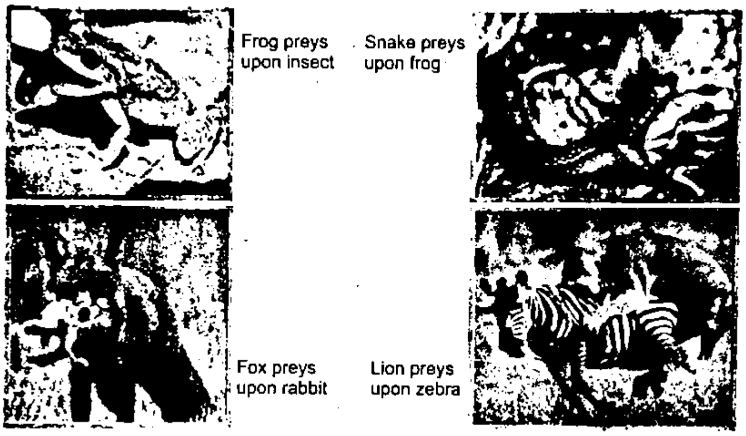


Figure 16.9: Examples of Predators and Their Preys

2. Certain plants (Pitcher plant, Sundew, Venus fly trap etc.) are carnivorous and live as predators. Such plants live in the areas where minerals and other nutrients are lacking. They feed on insects to fulfill their nitrogen requirements. These plants have mechanism to attract insects. For example, they secrete sweet nectar that attracts the insects searching for food. Their leaves are also modified to capture the prey.

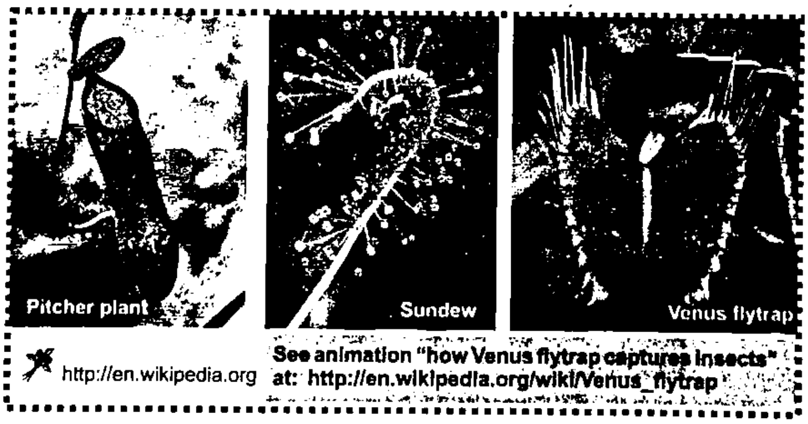


Figure 16.10: Predator Plants

Importance of predation

Predation keeps the prey population under check, so as to maintain an ecological balance. Humans benefit from this interaction in the biological control of weeds and pests. In order to control pests in an area, their predators are released there.

3) Symbiosis

Definition

It is a relationship between members of different species, in which they live together for longer or shorter periods of time.

Example

Lichens (Association between algae and fungi)

Types of symbiosis

A. Parasitism (Board 2013)

Definition

It is a type of symbiosis in which smaller partner (parasite) derives food and shelter from the body of larger partner (host) and, in turn, harms it.

Host

The organism on which a parasite feeds is called host.

Parasite

Parasite is an organism that gets shelter and food from its host and in return harms it. Host can survive without parasite, but parasite cannot survive without host.

Types of Parasites

a) Ectoparasites

Ectoparasites live outside i.e. on the surface of host's body and get food from there.

Examples

Mosquitoes, leeches, lice etc.

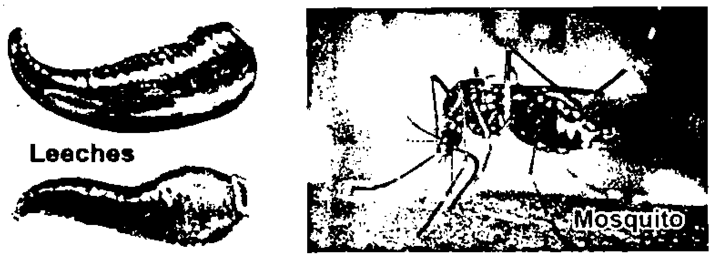


Figure 16.11: Ectoparasites

b) Endoparasites

Endoparasites live inside the body of host and get food and shelter from there.

Examples

Bacteria, viruses, tapeworm, Ascaris, Entamoeba, Plasmodium etc.

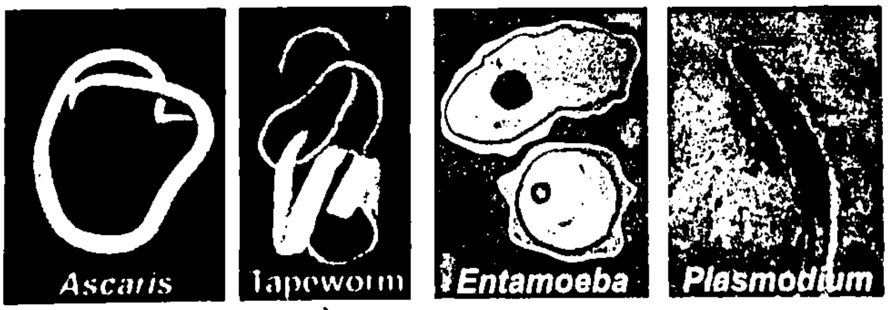


Figure 16.12: Some Endoparasites

Parasitic Plants

Some plants (e.g. Cuscuta, also called dodder) are parasites on other plants. Parasitic plants grow special types of roots (haustoria) into host body and suck the required nutrients from the vascular tissues of host.



Figure 16.13: A parasitic plant and its host tree trunk

Types of Parasitism

a) Temporary Parasitism

In temporary parasitism, the parasite spends most of its life cycle as independent free- living organisms. Only a part of its life cycle is spent as a parasite. Leech, bed bug, mosquito are common temporary parasites of humans.

b) Permanent Parasitism

In permanent parasitism, the parasites spend their whole life cycles as parasites. Many disease causing bacteria and all viruses are permanent parasites.

B) Mutualism

The type of symbiosis in which both partner get benefit from each other and neither is harmed.

Examples

(i) Termites eat wood but are unable to digest it. A protozoan called zooflagellate lives in its intestine. It secretes 'cellulase' enzyme to digest the cellulose of wood. In turn, the termite provides food and shelter to the protozoan.

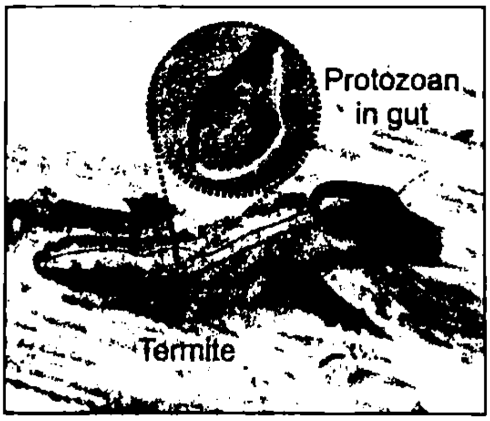


Figure 16.14: Termite, with a Protozoan in its gut

(ii) The nitrogen fixer bacteria *Rhizobium* live in the root nodules of leguminous plants like pea, gram etc. The bacteria obtain food and shelter from plants while in return they fix gaseous nitrogen into nitrates for the plant which is required for their growth.

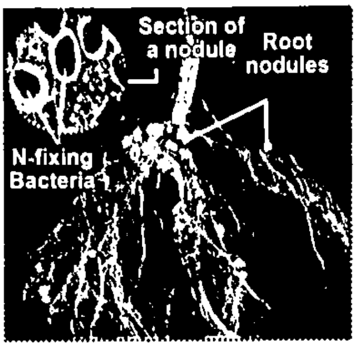


Figure 16.15: Bacteria in Root Nodules

C) Commensalism

It is a type of symbiosis in which one partner is benefited while the other is neither benefited nor harmed.

Examples

i. Epiphytes are small plants found growing on other larger plants for space only. They absorb water and minerals from the atmosphere and prepare their own food. The larger plants are neither benefited nor harmed in any way.
ii. Sucker fish attaches to the surface of sharks by its sucker. In this way, the shark provides easy transport to the sucker fish to new feeding grounds.



Figure 16.16 (a): An Epiphyte Orchid Plant Growing on a Tree Trunk.

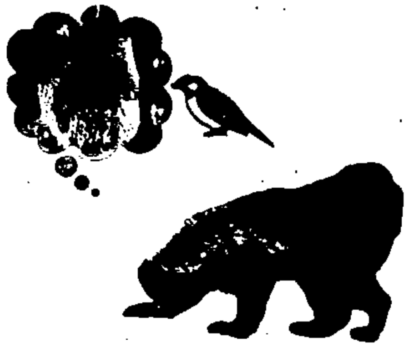


Figure 16.16 (b): A Sucker Fish Attached with Shark

iii. An example of commensalism (Honey Guide bird and Badger)

The honey guide bird feeds on wax and the larvae present in honeycombs. It flies around looking for honeycombs, but it is not strong enough to open the comb. Badgers are large mammals that feed on honey. When a honey guide bird goes to find honeycombs, the badger follows it. When

the bird find a honeycomb, it calls the badger. Sometimes the bird has to stop and wait for the slow-moving badger. After reaching there, the badger open the honeycomb and both of them eat their foods together. Traditionally, humans have also used these birds to find honeybee colonies.



Q. 9 Explain Ecosystem Balance and Human Impact.

Ans: (a) Interaction among organisms

The interactions among organisms and between organisms and their abiotic components of their environment produce steady and balanced ecosystem.

(b) Biogeochemical cycles

Biogeochemical cycles also maintain the balance in ecosystems by recycling natural resources, so that they do not deplete.

(c) Disturbance of the balance in ecosystem

Humans try to modify environment (e.g. cutting of trees) to fulfill their needs. This has upset the delicate balance in ecosystems and nature as well. Some of the human impacts on the balance of ecosystems and nature are described as follows;

1. Global Warming

(a) Process of temperature increase

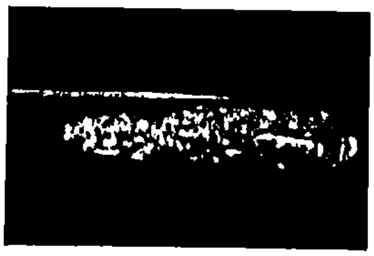
The addition of greenhouse gases (e.g. carbon dioxide, methane, ozone) in atmosphere increases the temperature of the earth. These gases in the lowest part of Earth's atmosphere do not allow solar radiations to reflect back into space. As a result, heat remains within the Earth's atmosphere and increases its temperature. This is called global warming.

(b) Effect of global warming

Due to global warming, polar ice-caps and glaciers are melting faster than the time taken for new ice layers to form. Sea water is also expanding causes sea level to rise. Due to melting glaciers, rivers overflow and cause floods.

(c) Threat to the Maldives' Survival

Scientists fear that the sea level is rising up to 0.9 cm a year. Rise in sea level has worst effects on coastal countries. Most of the islands of the Maldives are less than 1 metre above sea level. It is estimated that within 100 years, the Maldives might become uninhabitable and the citizens would be forced to evacuate.



(d) Green House Effect

It refers to the phenomenon in which certain gases (Carbon dioxide, methane, nitrous oxide) called greenhouse gases trap heat in the atmosphere. These gases act like the glass in a green house, which does not allow the inner heat to escape. When sunlight reaches the surface of the earth, much of its energy is transformed into heat energy. The earth surface reflects this heat energy towards space as infrared radiation. The greenhouse gases trap these and send it back to earth which increases temperature.

2. Acid rains

Certain chemicals such as oxides of sulphur and nitrogen when react with water vapours in the presence of sunlight to form sulphuric acid and nitric acid. These acids remain as vapours at high temperatures. As temperature falls, the acids begin to condense into liquid form and mix with rain or snow. On the way down to the earth, this makes rain acidic with pH range of 3-6.

Effects of acid rains

1) Lowering in pH

Acid rain destroys the necessary nutrients present in the water of rivers and lakes etc. It also lowers the pH of water. Most of the aquatic animals cannot survive at this pH.

2) Damages to Plants

Acid rain washes nutrients out of soil, damages the bark and leaves of trees and harms root hairs. Leaf pigments (chlorophyll) are also destroyed.

3) Corrosion on Metallic surfaces

Metallic surfaces exposed to acid rain are easily corroded. Fabrics, paper and leather products also lose their material strength.

4) Weakening on Building Material

Building materials such as limestone, marble, dolomite, mortar and slate are weakened with acid rains because of formation of soluble compounds. The building of famous Taj Mahal has been corroded at many places, due to acid rains.

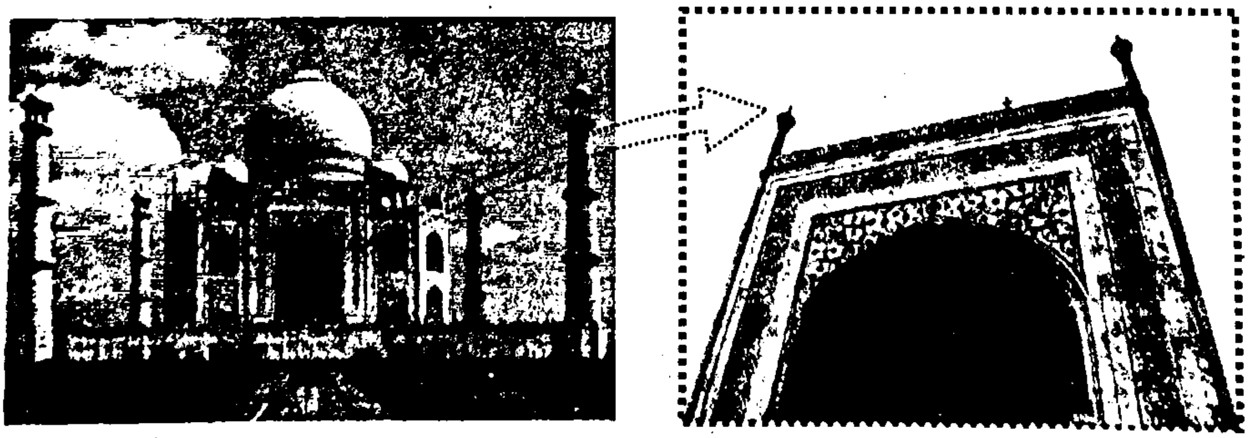


Figure 16.17: Taj Mahal and its Corroded Door

3. Deforestation:

Definition

Deforestation means clearing of forests by natural causes or humans.

Causes of deforestation

- Large areas of forests have been cleaned for agriculture, factories, roads, rail tracks and mining.
- Humans cut trees for getting wood (lumber), which is then used for making structures and for heat production.
- Human preys upon forest animals, which are the predators of many insect pests. In this way, insect pests destroy forests by eating the shoots and spreading diseases.



Figure 16.18: Forests are Cut for Making Roads

Effects of deforestation

- Floods
- Droughts
- Landslides
- Soil erosions
- Global warming
- Loss of habitat of many species

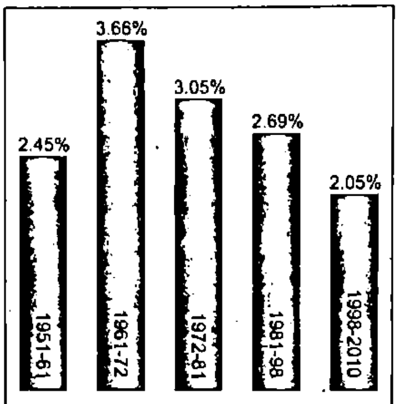
4. Overpopulation

Growth of population

When the industrial revolution started some 250 years ago, the world population was 600 million that time seems like a lot of people but now the world population is almost ten times at 6 billion and will grow to 8 billion by 2025.

Causes of Overpopulation

Better health facilities and lowered mortality rates have contributed in population growth.



PAKISTAN POPULATION GROWTH RATES
Source: Pakistan Economic Survey
Ministry of Population Welfare,
Government of Pakistan

Year	Population	Year	Population
1981	85,096,000	1999	132,790,000
1984	92,284,301	2002	144,902,409
1987	99,953,232	2005	155,772,000
1990	107,975,060	2008	166,111,487
1993	116,444,165	2009	169,708,303
1996	126,409,851	2010	173,510,000

The Population of Pakistan
Source: The World Bank

5. Urbanization:

Definition

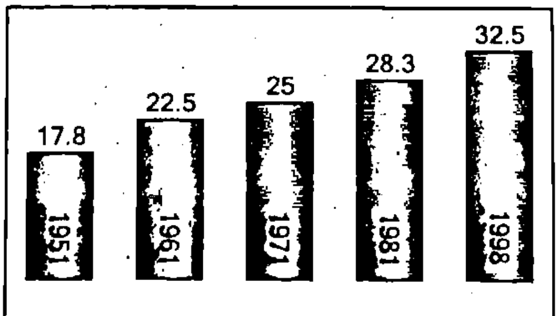
Urbanization means growing of cities.

Cause of urbanization

People move from rural areas to cities in search of better jobs, education opportunities and higher standards of living.

Effects of rapid urbanization

1. If there is rapid urban growth, the governments find it difficult to provide even the basic facilities like health, education, shelter, water, electricity etc.
2. Most of the migrants in cities do not find good jobs and become the part of urban poor.
3. There is overcrowding in schools, hospitals etc.
4. The slum areas increase in number and people living there are at greater risk of diseases.



PAKISTAN: URBAN POPULATION (%age)
Source: The World Bank

Methods to solve problems created by urbanization

Urbanization is a global problem and cannot be stopped but it can be managed. The current level of urbanization in Pakistan is about 32% which is not high by global standards. A planned urbanization can solve many problems.

1. The cities should have thick green belts in their surroundings to control pollution.
2. The open spaces in cities should be reserved through zoning and land plans.
3. The urban spread out should also be controlled.
4. Utilization of public transport instead of individual transports also proves effective way to manage urbanization.

Q. 10 Define and explain different types of Pollution.

Ans. Definition

Pollution is defined as any undesirable change in the physical, chemical or biological characteristics of air, water and land that may harmful for humans, other living organisms and natural resources.

Pollutants

The agents which are responsible for pollution are called pollutants.

Types of Pollutants

Pollutants are of two types i.e. biodegradable and non-biodegradable.

Sources of pollutants

They may be the industrial effluents, domestic wastes, medical wastes.

Examples

CO_2, CO, SO_2, CFCs etc.

Types of Pollution

A) Air Pollution

Definition

It is defined as the change of composition in the air by the addition of harmful substances (e.g. industrial and automobile gases and particulate matter).

Sources of Air Pollution

All sources of air pollution are related to human activities. Burning of coal produces a lot of smoke and dust whereas burning of petroleum produces sulphur dioxide. In addition to these, air pollutants include the carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons, particulate matter and traces of metals. Different industries produce air pollution in the following ways:-

- **Fertilizer Industries**

  Fertilizer industries release oxides of sulphur and nitrogen, hydrocarbons, particulate matter and fluorine.

- **Thermal Industries**

  Thermal industries are coal based and their pollutants are fly ash, soot and sulphur dioxide.

- **Textile Industries**

  Textile industries release cotton dust, nitrogen oxides, chlorine, smoke and sulphur dioxide.

- **Steel Industries**

  Steel industries release carbon monoxide, carbon dioxide, sulphur dioxide, phenol, fluorine, cyanide, particulate matter etc.

Effects of air Pollution (Board 2013)

1. Global Warming

It is known that global warming is one of the consequences of air pollution. According to estimates, at the current rate of increase, the average global temperature will go up by 3°C to 8°C in next 100 years. Other effects of air pollution are as follows;

2. Smog Formation

When pollutants like hydrocarbons and nitrogen oxides combine in the presence of sunlight, smog is formed. This is a mixture of gases. It forms a yellowish brown haze especially during winter and hampers visibility. It also causes many respiratory disorders and allergies as it contains polluting gases.

3. Acid Rains

The air pollutants like sulphur dioxide and nitrogen oxides react with water vapours in the atmosphere producing acid rains.

4. Ozone Depletion

Upper layer (stratosphere) of the atmosphere has ozone (O_3) which absorbs ultraviolet rays present in the sun's radiations. However the air pollutants like chlorofluorocarbons (CFCs) destroy the ozone molecules and so break the ozone layer. Ozone holes are created which permit UV rays to reach the Earth's surface. The UV rays increase the temperature and also cause skin cancers.



The harmful effects of the UV rays are visible in the countries such as Australia and New Zealand where the rate of skin cancer is higher than the other regions of the world.

Control of Air Pollution

For effective control of air pollution, it is important to create public awareness about the ill effects of air pollution. Air pollution can be controlled by following ways:

1) Afforestation

It means the establishment of new forests by planting on non-forest areas. Forests are effective means to control air pollution because plants can filter and absorb air pollutants.

2) Modification of industrial effluents

The air pollutants coming from industries should be passed through filters and other devices, so that the particulate matter is removed before the waste gases are released out. The smoke producing units should have long chimneys to take the polluting gases far above and then disperse over a larger area. Industries should also invest for solar cookers or for producing bio gas.

3) **Environment friendly fuels**

Lead-free fuels should be used in automobiles. Similarly sulphur-free fuel should be used in coal-based industry to reduce pollution by sulphur dioxide.

B) Water Pollution

Definition

It is the change in the composition of water by the addition of harmful substances. Water pollution severely affects the health of people.

Sources of Water Pollution

- **Sewage**

Sewage is one of the major pollutants of water. It contains organic matter and the excreta of humans and other animals. Organic matter encourages the growth of micro-organisms which spread diseases.

- **Industrial Wastes**

i. The wastes of industries (acids, alkalis, dyes and other chemicals) are disposed in nearby water bodies. These wastes change the pH of water and are harmful or even fatal to aquatic organisms.

ii. Certain industries release a lot of hot water from their cooling plants. It results in heating up of water bodies and kills aquatic life.

- **Fertilizers and Pesticides**

Fertilizers and pesticides enter into water bodies with the rain water flow and the ground water by seepage. These chemicals remain in water for a long time and can enter food chains. They cause a number of diseases in animals.

- **Petroleum Hydrocarbons**

Oil tankers and offshore petroleum refineries cause oil leakage into water. Oil floats on the water surface and prevents atmospheric oxygen from mixing in water. So, aquatic animals begin to die due to shortage of oxygen.

- **Heavy Metals**

Some heavy metals e.g. Lead, Mercury, Arsenic and Cadmium also make the water polluted. Such metals can be present in the water, released from industrial and urban areas. If water with such heavy metals is given to plants, the metals enter the vegetables that grow on these plants. Such contaminated vegetables are harmful for human health.

Diseases in humans

i. Heavy metals reduce growth and development, and cause cancer and nervous system damage.

ii. Mercury and Lead can cause joint diseases such as rheumatoid arthritis, diseases of Kidneys, circulatory system and nervous system.

Tanneries

There are more than 200 tanneries (industry where raw skin is treated to make leather) operating in Kasur city.

(a) Industrial Discharge

The industry discharges 9000 cubic meters of water daily into the nearby water bodies. This water contains heavy metals and becomes the part of the underground water.

(b) Effects

(i) In 2003, a survey showed that two-thirds of residents and 72% of tannery workers suffered cancer, infections of the Kidneys, or loss of eyesight.

(ii) Tests showed that the drinking water was contaminated with Lead, Mercury and Chromium.

(c) Kasur Tannery Pollution control project

Pakistan government and the United Nations development programme (UNDP) launched the Kasur tannery pollution control project. The project has established an effluent treatment plant, chromium plant and a solid waste disposal site.

Effects of water pollution

The followings are the major effects of water pollution.

I. Eutrophication

Enrichment of water with inorganic nutrients (nitrates and phosphates) is called eutrophication. The sewage and fertilizers contain large amount of inorganic materials. When sewage and fertilizers reach water bodies, the nutrients present in them promote algal blooms (excessive growth) there. Rich algal growth leads to increase in the number of decomposers.

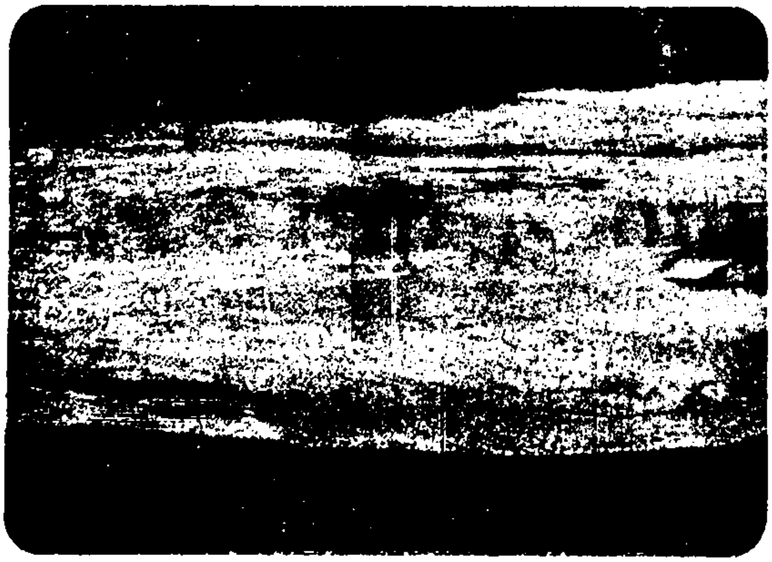


Figure 16.19: Eutrophication in a Lake

Harmful effects of eutrophication

1) Decomposers use the oxygen present in water and it results in the depletion of oxygen.
2) Algal bloom also reduces the light reaching the lower layers of water.

II. Food chain Contamination

The non-biodegradable water pollutants may stay in water for long times. From water, they enter into small organisms, which are fed upon by fish. The fish in turn are fed upon by land animals including humans.

III. Epidemics

Organic pollutants in water facilitate the growth of germs. Such polluted water causes epidemics like cholera, gastroenteritis etc.

Control of Water Pollution

The following methods should be used to control water pollution:

1) Public should be made aware of the dangers of water pollution.
2) Before releasing the sewage into water bodies, it must be treated through sewage treatment techniques.
3) Industrial wastes should also be treated before they are released into water bodies.

C) Land Pollution

Definition

It is the change in the composition of land (soil) by the addition of harmful substances.

Land is an important resource as it is the basis for the growth of producers. In the recent times, soil has been subjected to the pollution.

Causes of Land Pollution

1) The pesticides used in agriculture have chemicals that stay in soil for long times.
2) The acid rains change the pH of soil making it unsuitable for cultivation.
3) The household and other city garbage lies scattered in soil in the absence of a proper disposal system.
4) Materials like polythene block the passage of water into soil and so decrease the water holding capacity of soil.



Figure 16.20 Can We Control Land Pollution?

5) Many industries produce harmful chemicals which are disposed off without being treated.
6) Improper disposal of nuclear wastes also causes radioactive substances to remain in soil for a long time.
7) Open latrines in villages and some part of the cities are also the source of land pollution.

Control of Land Pollution

- There should be suitable and safe disposal of wastes including nuclear wastes.
- Non- biodegradable materials like plastic, glass, metals etc. should be recovered and recycled.
- Inorganic pesticides should be replaced by organic pesticides.

D) Noise Pollution

Definition

Unwanted, unpleasant and annoying sounds are termed as noise. Noise is also considered as a form of pollution.

Effects

Annoyance and aggression, hearing loss, depression, hypertension etc.

Q.11. Explain Conservation of Nature.

Ans. Definition

Conservation of nature means the conservation of natural resources. Everything that we use or consume e.g. food, petrol etc. is obtained from natural resources.

Types of resources

a. **Renewable natural resources**

b. **Non-renewable resources**

a) **Renewable natural resources**

The renewable natural resources e.g. air is reproduced easily.

b) **Non-renewable resources**

The non-renewable resources (e.g. minerals and fossil fuels) are not replenished once they get depleted. We have to conserve the non-renewable resources because their reserves are limited and humans are heavily dependent on them for daily needs. The renewable resources too have to be judiciously used. To ensure sustainable use of resources in our environment, we should act upon the principle of 'The 3R' i.e. Reduce, Reuse and Recycle.

The R1: Reduce

We should use the natural resources less and should not waste them. We should use this principle at different places, in our daily lives. We should not waste water, electricity, fuel etc. We should turn off the tap when not in use. We should bath with a bucket instead of shower. The lights and fans should be off when we are not in room. We should take public transport or walk short distances instead of using motor fuel. We should not waste food and should give unused food to poor people.

The R2: Reuse

We should use things again and again. We should not throw away materials such as glass containers, plastic bags, paper, cloth etc. These should be reused at domestic levels rather than being thrown. It also reduces solid waste pollution.

A recycling of one tonne of paper can save 17 trees.

The R3: Recycle

Materials such as paper, plastic, glass etc. can be recycled. This decreases the volume of refuse and helps in conservation of natural resources.

The R4: Reforest

Trees should be planted. Trees make our environment more cool, shady and green.

Plans for the Conservation of Nature

The following are the projects and plans of our government for the conservation of other resources.

1- National Conservation Strategy

In 1992, Pakistan developed the National Conservation Strategy. The main objectives of this strategy are conservation of natural resources and improved efficiency in the use of resources. It also covers the policies for promoting efficiency and conservation of energy resources.

2- National Drinking Water and Sanitation Policy

The Federal Ministry of Environment has launched the national Drinking Water and Sanitation Policy. It focuses on the provision of clean drinking water to entire population and the conservation of the water resources. Water purification plants are being installed all over the country.

3- Mass awareness for water Conservation and Management

In 2006, the UNDP (UN Division for Sustainable Development) launched the project "Mass Awareness for Water Conservation and Management". The objective of the project was to launch a comprehensive awareness campaign for the conservation and management of water resources in Pakistan.

4- Society for conservation and protection of Environment

The organization SCOPE (Society for Conservation and Protection of Environment) works with the government for mass awareness and research of the conservation of natural resources in Pakistan.

> Clean water, air, fuels, agricultural land and forests appeared to be plentiful earlier, but now these are becoming scarce. If we continue depleting them like this, we will be creating untold misery for ourselves and for our future generations.

Role of WWF

The WWF (old name is World Wildlife Fund but now it is called World Wide Fund for Nature) is working on many projects related to the conservation of nature. The following are some important programmes of WWF-Pakistan (in collaboration with the government of Pakistan).

1) Improving sub-watershed management and environmental awareness around Ayubia National Park.
2) Plantation of trees of Jatropha and Mangroves at District Thatta, Sindh.
3) District-wise forest covers assessment of Pakistan.
4) Saving Wetlands Sky High Programme (for the conservation and management of high altitude wetlands).
5) Indus Basin Water Security Project (to protect the water-flow needed for the maintenance of river ecosystem and for the benefit of nearby areas).
6) Regional Climate Risk Reduction in Himalayas.

Q.12 Write a note on Dengue Fever.

Ans: Introduction

It is a viral infection transmitted through a mosquito *Aedes aegypti*.

Occurrence

It has become a major health problem in tropical and sub-tropical countries, including Pakistan.

Types of Dengue Virus

There are four types of dengue viruses. Recovery from infection by one provides lifelong immunity against that virus but provides no protection against infection by the other three.

Dengue Infection per year

According to WHO, there are 50 million dengue infections worldwide every year. Now there are 2.5 billion people at risk from dengue.

Spreading

The female *Aedes* mosquito gets the virus when it bites an infected person. When an infected mosquito bites another person, viruses enter his/her blood and attack white blood cells. Inside WBCs, viruses reproduce and destroy them.

In severe cases, the virus affects liver and bone marrow. As a result there is a decrease in the production of blood platelets and patient suffers from bleeding.

Other symptoms

High fever, severe headache, pain behind eyes, muscle joint pains and rash



Adult → Eggs of Aedes → Larva of Aedes → Pupa of Aedes

DHF and DSS

Sometimes, dengue fever converts into dengue haemorrhagic fever (DHF) or into dengue shock syndrome (DSS). DHF results in bleeding, low levels of blood platelets and blood plasma leakage. In DSS, the blood pressure falls dangerously low.

Treatment

There is no vaccine or treatment for dengue fever.

Control

(a) Check the spreading of *Aedes*

At present, the only method of controlling dengue virus transmission is to check the spread of *Aedes* mosquitoes. *Aedes aegypti* breeds primarily in the containers used for water storage, discarded plastic containers, used automobile tyres and other items that collect rainwater.

(b) Proper solid waste disposal

The mosquitoes can be controlled through proper solid waste disposal and improved water storage practices.

(c) Killing the Larvae of the Mosquito

Small fish and crustaceans have also been used for killing the larvae of the mosquito. Insecticide sprays have not proved efficient in killing the mosquitoes because spray does not penetrate all habitats of adult mosquitoes.

Unit 17

Biotechnology

Long Answer Questions

Q.1 Define biotechnology? Explain its background.

Ans: Definition **(Board 2014)**

Biotechnology is defined as the use of living organisms in processes for the manufacture of useful products or for services.

Background

(a) Old Biotechnology

Although the term biotechnology is new, the discipline itself is very old. Fermentation and other such processes which are based on the natural capabilities of organisms, are commonly considered as old biotechnology.

(b) Modern Biotechnology

Genetic engineering i.e. the artificial synthesis, modification, removal, addition and repair of genetic material (DNA) is considered as modern biotechnology. It is done to alter the characteristics of organisms.

(c) Isolation of enzymes of DNA Synthesis

The work on genetic engineering started in 1944 when it was proved that DNA carries the genetic information.

Scientists isolated the enzymes of DNA synthesis and then prepared DNA outside cells.

(d) Cutting and Pasting of DNA

In 1970s, scientists were able to cut and paste the DNA of organisms.

(e) Preparation of insulin and human growth hormone

In 1978, scientists prepared human insulin by inserting the insulin gene in bacteria. Human growth hormone was also synthesized in bacteria.

(f) Human Genome Project

In 1990, the **Human Genome Project** was launched to map all the genes in human cell. The complete map of human genome was published in 2002.

Q.2 Since when have humans been using microorganisms?

Ans: Humans began using microorganisms as early as 4000 BC for making wine, vinegar, cheese, yogurt etc. Some of these processes have become a part of every home that we may even hesitate to refer them as biotechnology.

Q.3 What do you know about Dolly?

Ans: In Scotland, in 1997, an embryologist Ian Wilmut produced a sheep (Dolly) from the body cell of an adult sheep.



Q.4 Write down scope and importance of biotechnology in three different fields. (B-2014)

Ans: In recent years, biotechnology is growing as a separate science. It has attracted the attention of many intellectuals from diverse fields like agriculture, medicine, microbiology and organic chemistry.

The scope for biotechnology is so wide that it is difficult to recognize the limits.

The following are some areas of the application of biotechnology:

1. Biotechnology in the field of medicine./Write the scope and importance of biotechnology in the field of medicine (Board 2014)

(a) Synthesis of insulin and interferon

In the field of medicine, biotechnologists synthesized insulin and interferon (antiviral protein) from bacteria and released for sale.

(b) Vaccines and Antibodies

A large number of vaccines and antibodies; human growth hormone and other medicines have also been produced.

(c) Synthesis of enzymes

Various enzymes are being synthesized for medicinal as well as industrial use.

(d) Gene therapy and forensic medicines

Gene therapy (treatment through genes) has become important in recent years. Biotechnology also proved much beneficial in forensic medicines. The study of DNA helps in the identification of criminals.

2. Biotechnology in the field of food and agriculture

(a) In Food Production

Fermented foods (e.g. pickles, yogurt), malted foods (e.g. powdered milk: a mixture of barley, wheat flour and whole milk), various vitamins and dairy products are produced by using microorganisms.

(b) In Wine and beer Production

Wine and beer are produced in beverage industry. Biotechnology has also revolutionized research activities in the area of agriculture.

(c) Transgenic Plants and Animals

Transgenic (organisms with modified genetic set-up) plants are being developed, in which desirable characteristics are present e.g., more yields and resistance against diseases, insects and herbicides.

Transgenic goats, chickens, cows give more food and milk etc. Many animals like mice, goats, cows etc. have been made transgenic to get medicines through their milk, blood or urine.

3. **Biotechnology and environment**

(a) **Biotechnology and environment issues**

Biotechnology is also being used for dealing with environmental issues, like pollution control, development of renewable sources for energy, restoration of degraded lands and bio-diversity conservation.

(b) **Sewage Water Treatment**

Bacterial enzymes are used to treat sewage water to purify.

(c) **Transgenic Microbes**

Microbes are being developed to be used as biopesticides, biofertilizers, biosensors etc. Such transgenic micro-organisms are also used for the recovery of metals, cleaning of spilled oils and for many other purposes.

Q.5 What is Fermentation and write down its types.

Ans. Cellular respiration;

In cellular respiration glucose molecule goes through oxidation reduction reactions to release energy in the form of ATP.

Fermentation

Fermentation is the process in which there is incomplete oxidation – reduction of glucose.

Fermentation has been in the knowledge of man since centuries but it was believed that it is purely a chemical process.

Louis Pasteur and Fermentation

In 1857, Pasteur convinced the scientific community that all fermentations are the results of microbial activity. He showed that fermentation is always accompanied by the development of micro-organisms. There are many kinds of fermentation and each kind is a characteristic of particular microbial group.

Types of Fermentation **(Board 2013)**

Fermentations are classified in terms of the products formed. The initial steps of carbohydrate fermentation are identical to those of respiration. The process begins with glycolysis, in which the glucose molecule is broken into two molecules of pyruvic acid. Different micro-organisms proceed the further reactions in different ways. It results in the formation of various products from pyruvic acid.

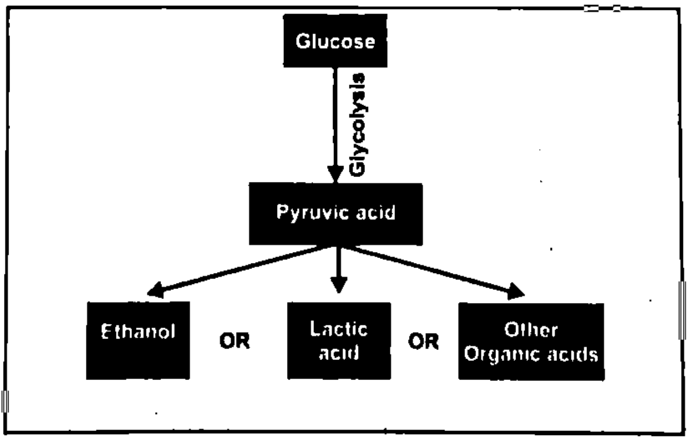


Figure 17.1: Carbohydrate Fermentation and its Products

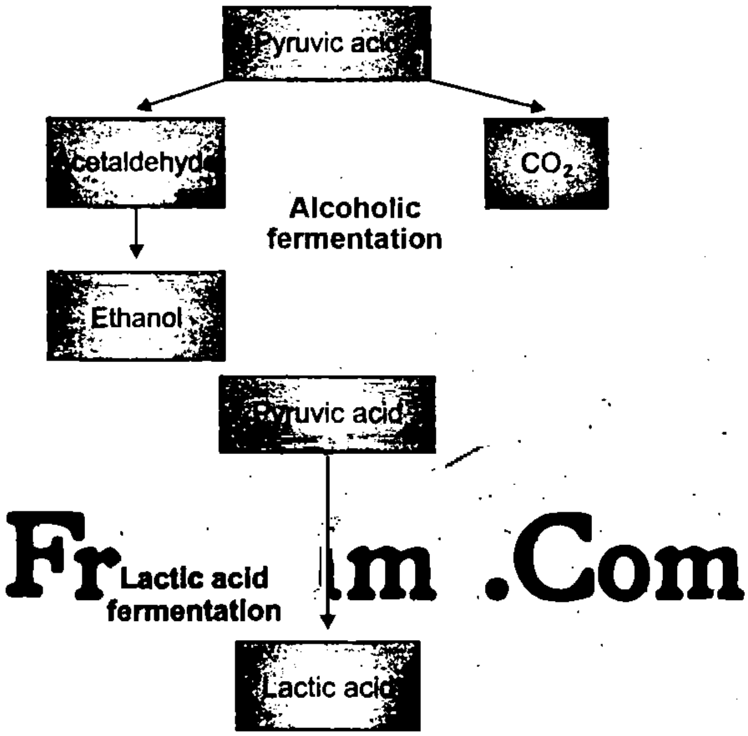
The two basic types of carbohydrate fermentation are:

1. **Alcoholic Fermentation (by yeast)**

This fermentation is carried out by many types of yeast such as *saccharomyces cerevisiae*. This process is quite important and is used to produce bread, beer, wine and distilled spirits. In this process, carbon dioxide is removed from pyruvic acid. The product i.e. acetaldehyde is then reduced to ethanol. The carbon dioxide produced during this fermentation causes the rise of the bread.

2. **Lactic acid Fermentation (by bacteria)**

In this process, pyruvic acid is reduced to lactic acid. It is carried out by many bacteria e.g. *Streptococcus* and many *Lactobacillus* species. It is quite important in dairy industry where it is used for souring milk and also for production of various types of cheese.



Q.6 What are applications of fermentation in biotechnology?

Ans. In beginning, the meaning of fermentation process was the use of microorganisms for the production of foods (cheese, yogurt, fermented pickles and sausages, soy sauce), beverages (beers, wines) and spirits. However, in biotechnology the term "fermentation" means the production of any product by the mass culture of microorganisms.

Applications of fermentation

In fermentation, maximum growth of an organism is obtained for the production of desired products of commercial value. Traditionally, only food and beverage products were produced by using fermentation. Now many other products e.g. industrial chemicals are also being produced.

a) **Fermented foods**

Fermentation often makes the food more nutritious, more digestible and tastier. It also tends to preserve the food, lowering the need for refrigeration. The following groups are included in the fermented foods.

1) Cereal products

Bread is the commonest type of fermented cereal product. Wheat dough is fermented by *S.cerevisiae* along with some lactic acid bacteria.,

2) Dairy products

Cheese and yogurt are important fermentation products. Cheese is formed when a milk protein is coagulated. This happens when the acid produced by lactic acid bacteria reacts with milk protein. Yogurt is made from milk by different lactic acid bacteria.

3) Fruit and vegetable products

Fermentation is usually used, along with salt and acid, to preserve pickle, fruits and vegetables.

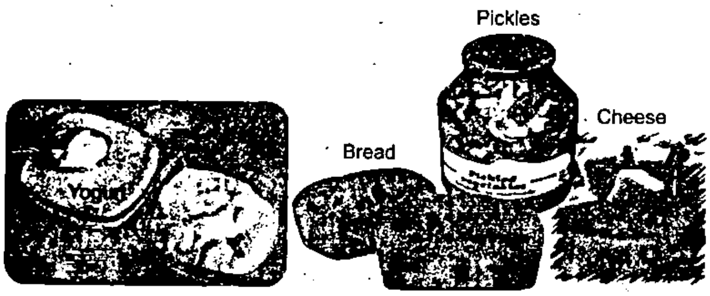


Figure 17.2: Fermented Foods

4) Beverage products.

Beer is produced from cereal grains which have been malted, dried and ground into fine powder. Fermentation of the powder is done by yeast. This process breaks the glucose present in powder into pyruvic acid and then into ethanol. Grapes can be directly fermented by yeast to wine.

b) Industrial products

The following are important industrial products produced through the process of fermentation.

Products	Microorganisms used	Some uses
Formic acid	*Aspergillus*	Used in textile dyeing, leather treatment, electroplating, rubber manufacture
Ethanol	*Saccharomyces*	Used as solvent, used in the production of vinegar and beverages
Gylcerol	*Saccharomyces*	Used as solvent, used in the production of plastics, cosmetics and soaps, used in printing, used as sweetner.
Acrylic acid	*Bacillus*	Used in printing; used as sweetener. Used in the production of plastics.

Q.7. What is fermenter and write down its types. **(Board 2014)**

Ans. Fermenter

Fermenter is a device that provides optimum environment to micro-organisms to grow into a biomass, so that they can interact with a substrate, forming the product.

Types

Fermentation is carried out in fermenters, in the following two ways:-

1) Batch Fermentation

In this process, the tank of fermenter is filled with the raw materials to be fermented. The temperature and pH of microbial fermentation is properly adjusted and nutritive supplements are added. All the material is steam sterilized. The pure culture of micro-organisms is added to fermenter from a separate vessel.

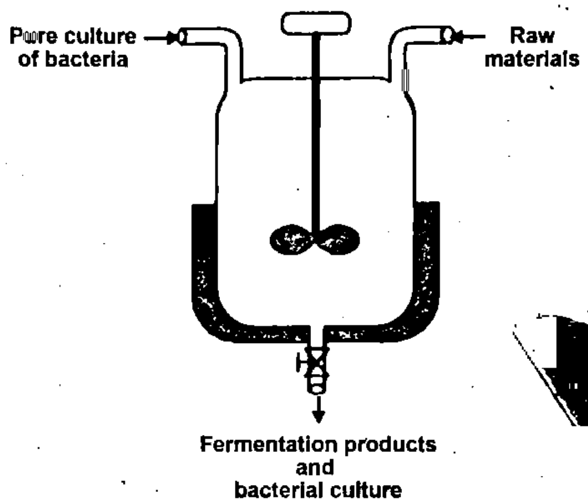


Figure 17.3 A batch Fermenter

Fermentation proceeds and after the proper time the contents of fermenter are taken out. Fermenter is cleaned and the process is repeated. Thus, fermentation is a dis-continuous process divided into batches.

2) Continuous fermentation

In this process, the substrate is added to fermenter continuously at a fixed rate. This maintains the micro-organisms in growth phase. Fermentation products are taken out continuously. The design and arrangements for continuous fermentation are more complex.

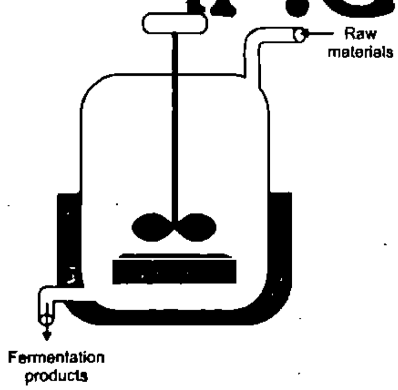


Figure 17.4 A Continuous Fermenter

Q.8 Write two advantages of using fermenters. **(Board 2014)**

Ans. Advantages of using fermenters

(1) Controlled Environment

For each biotechnological process, the environment provided to the organisms must be monitored and controlled. Such a controlled environment is provided by fermenters. A fermenter optimizes the growth of the organisms by controlling many factors, like nutrients, oxygen, growth inhibitors, pH and temperature.

(2) Production of materials in bulk quantities

A fermenter may hold several thousand litres of the growth medium. So fermenters allow the production of materials in bulk quantities. Massive amounts of medicines, insulin, human growth hormone and other proteins are being produced in fermenters and this production proves much inexpensive.

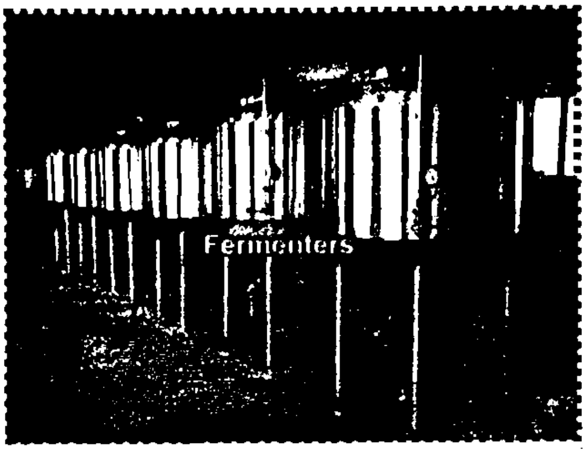


Figure 17.5: Fermenters used in food and Pharmaceutical industry

Q.9 What is genetic engineering and write down it objectives.

Ans. Definition

Genetic engineering or recombinant DNA technology involves the artificial synthesis, modification, removal, addition and repair of the genetic material (DNA).

Development of Genetic Engineering

Genetic engineering developed in the mid – 1970s when it became possible to cut DNA and to transfer particular pieces of DNA from one type of organism into another.

As a result, the characteristics of the host organism could be changed. If host organism is a microorganism, such as a bacterium, the transferred DNA is multiplied many times as the micro-organism multiplies. Consequently, it is possible to obtain millions of copies of a specific DNA inside a bacterial cell.

Objectives of genetic engineering

The important objectives of genetic engineering are as follows:

1) **Isolation of gene**
Isolation of a particular gene or part of gene for various purposes such as gene therapy.
2) **Production of RNA and protein**
Production of particular RNA and protein molecules.
3) **Production of enzymes, drugs and organic chemicals**
Improvement in the production of enzymes, drugs, and commercially important organic chemicals.
4) **Production of desirable plants**
Production of varieties of plants having particular desirable characteristics.
5) **Treatment of genetic defects**
Treatment of genetic defects in higher organisms.

Q.10 Write down basic steps in genetic engineering. **(Board 2013)**

Ans. All the objectives of genetic engineering can be obtained by some basic methodologies such as:

1) Isolation of gene of interest

In the 1st step, the genetic engineer identifies the gene of interest in a donor organism. Special enzymes called restriction endonucleases, are used to cut the identified gene from the total DNA of donor organism.

2) Insertion of the gene into a vector

Vector is selected for the transfer of the isolated gene of interest to the host cell. The vector may be a plasmid (the extra chromosomal DNA present in many bacteria) or a bacteriophage.

The gene of interest is attached with the vector DNA by using endonuclease (breaking enzymes) and ligase (joining enzymes). The vector DNA and the attached gene of interest are collectively called recombinant DNA.

3) Transfer of recombinant DNA into Host Organism

Recombinant DNA is transferred to the target host. In this way, host organism is transformed into a genetically modified organism (GMO).

4) Growth of the GMO

The GMO are provided suitable culture medium for growth to give as much copies of the gene of interest as needed.

5) Expression of the gene

The GMO contains the gene of interest and manufactures the desired product which is isolated from culture medium.

Q.11 What are different achievements of genetic engineering?

Ans. Various achievements of genetic engineering are as follows:

1) Formation of human insulin

Human insulin gene was transferred into bacteria. The genetically modified bacteria became able to synthesize insulin. Diabetics are now receiving this insulin.

2) Formation of human growth hormone

In 1977, an *E.coli* bacterium was created that was capable of synthesizing the human growth hormone.

3) Formation of thymosin hormone

The hormone thymosin which may prove effective against brain and lung cancer has been produced by genetically modified micro-organisms.

4) Formation of beta-endorphin

Beta-endorphin, a pain killer produced by the brain, has also been produced by genetic engineering techniques.

5) Formation of vaccines

Genetic engineers produced a safe vaccine against the foot and mouth disease (a viral disease in cattle, goats and deer). Similarly many vaccines have been produced against human disease such as hepatitis-B.

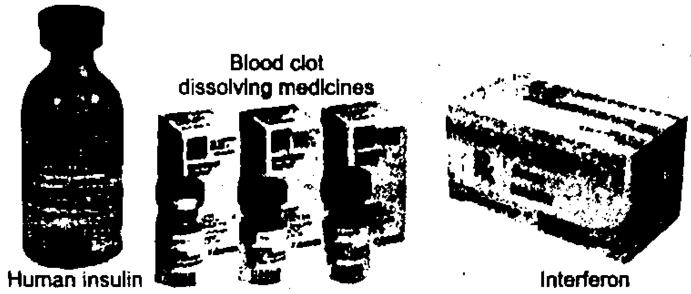


Figure 17.6 Some medicines produced by genetic engineers.

6) Formation of interferons

Interferons are anti-viral proteins produced by cells infected with viruses. In 1980, interferon was produced in the genetically modified micro-organisms for the 1st time.

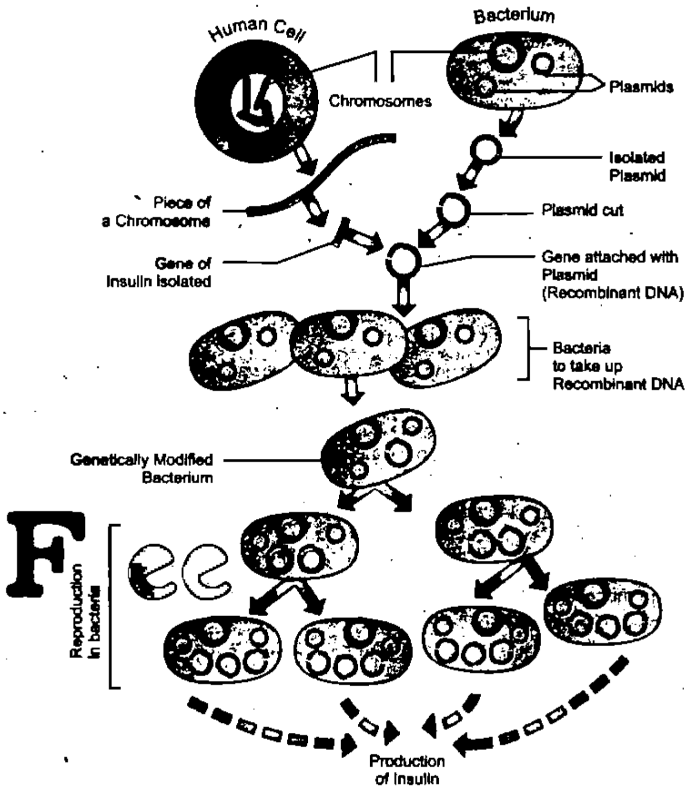


Figure 17.7 Production of insulin through genetic engineering

7) Formation of urokinase enzyme

The enzyme urokinase which is used to dissolve blood clots, has been produced by genetically modified micro-organisms.

8) Elimination of inherited diseases

Now it has become possible to modify the genes in the human egg cell. This can lead to the elimination of inherited diseases like haemophilia.

9) Cure of blood diseases

Genetic engineering techniques can also be used to cure blood diseases like thalassemia and sickle cell anaemia which result from defects in single genes. Normal genes could be transferred into the bone marrow.

10) Formation of nitrogen fixing plants

Genetic engineers have developed plants that can fix nitrogen directly from the atmosphere. Such plants need less fertilizers.

Q.12 What is single cell protein? Give its role in the service of humanity.

Ans. Definition

Single-cell protein (SCP) refers to the protein content extracted from pure or mixed cultures of algae, yeasts, fungi or bacteria.

OR

It is known as single cell protein because the micro-organisms used as producers are unicellular or filamentous individuals.

Production of Single Cell Protein

For the production of single cell proteins, the microorganisms are grown in fermenters. These microorganisms utilize a variety of substrate like agricultural wastes, industrial wastes, natural gas like methane etc.

Production of novel protein

Microorganisms grow very vigorously and produce a high yield of protein. The protein content produced by microorganisms is also known as novel protein or minifood.

Better management of Food Shortage Problem

Due to overpopulation, the world is facing the problem of food shortage. In future, the conventional agricultural methods might not be able to provide a sufficient supply of food (especially proteins). For a better management of food shortage problems (in human and domestic animals), the use of microbes as the producers of single cell proteins has been successful on experimental basis.

Work of Prof. Scrimshow

This technique was introduced by Prof. Scrimshow of Massachusetts Institute of technology. Scientist and food technologists believe that single cell proteins will substitute the other protein rich foods in human and animal feeds.

Significance of single cell protein

(a) High yield of SCP

All scientists recognize the significance of the production of single-cell proteins. The micro-organisms grow very vigorously and produce a high yield. It has been calculated that 50 kilogram of yeast produces about 250 tons of proteins within 24 hours.

Algae grown in ponds produce 20 tons (dry weight) of protein per acre/year. This yield of protein is 10-15 times higher than soybeans and 20-50 times higher than corn.

When single cell proteins are produced by using yeasts, the products also contain high vitamin content.

(b) Raw Material in the Production of Single cell Proteins

In the production of single cell proteins, industrial wastes are used as raw materials for micro-organisms. It helps in controlling pollution.

(c) Use of SCP in Future

The use of single cell proteins has good prospects in future because they contain all essential amino acids. Moreover the production of single-cell proteins is independent of seasonal variations.

(d) Limited land Area Required

SCP is gaining popularity day by day because it requires limited land area for production.

Unit 18

Pharmacology

Long Answer Questions

Q.1 What is pharmacology? Explain.

Ans. Pharmacology

Pharmacology is the study of drug composition, properties, medical applications and sources of drugs.

Explanation

Clinical pharmacology was present in the Middle Ages. Early pharmacologists focused on natural substances. It was developed in 19^{th} century as a biomedical science.

Q.2 Define Drug. What are its types?

Ans. Definition

Any substance that is absorbed into the body of a living organism, alters normal body function is known as a drug.

Types

Drugs are broadly classified into two types:

i. Pharmaceutical drug OR
Medicinal drug

It is defined as any chemical substance used in the diagnosis, cure, treatment or prevention of diseases.

ii. Addictive drugs

Some drugs often make person dependent on them, or addicted. These may be called as addictive drugs.

Q.3 Differentiate between pharmacology and pharmacy?

Ans: Pharmacology is the study of drug composition, properties, medical applications and sources of drugs while pharmacy is the study of preparation of medicines and drugs. Both terms are not synonymous. Though in common usage, the two terms are confused.

Q4. What is Materia Medica?

Ans: Until 1890, the subject of pharmacology was known as Materia Medica.



A page f[illegible] book of Materia Medica

Q.5 What are prescription drugs and Non-prescription drugs? Give examples.

Ans. Prescription drugs

These are sold only on physician's prescription. These include barbiturates, tranquillizers, antibiotics etc.

Non-Prescription drugs

These are sold over the counter because these are considered safe enough. These include aspirin and some cough medicines.

Q.6 What are the sources of drugs? Give examples?

Ans. Drugs

Any substance that absorbed into the body of a living organism, alters normal body function is known as a drug.

Sources of drugs:

Drugs are obtained from the following sources.

1. **Synthetic Drugs**

The drugs which do not occur naturally but are synthesized in laboratory. Pharmaceutical companies produce these drugs. e.g. Aspirin.

2. **Drugs from Plants and fungi**

Many important medicines are obtained from plants and fungi. These medicines include:

i. **Antibiotics**

The antibiotic penicillin comes from a fungus.

ii. **Cardiotonics**

The cardiotonic digitalis made from leaves of purple flowered plant foxglove used to stimulate heart.

iii. **Analgesics**

The pain reliever morphine is made from opium, which comes from the juice of opium poppy plant.

iv. **Addictive**

Many addictive illegal drugs e.g., marijuana are also obtained from plants.



Figure 8.1: Digitalis (Foxglove)

3. **Drugs from animals**

Drugs obtained from animals are usually their glandular products. Fish liver oil, musk, bees wax, certain hormones and antitoxins are obtained from animal sources.

4. **Drugs from minerals**

Several common drugs are obtained from minerals:-

i. The mineral iodine is used in making tincture of iodine, a liquid that helps to prevent infection when applied to cuts and bruises.

ii. The powder form of silver nitrate is applied on wounds to stop bleeding and prevent infection.

iii. While testing soil, researcher resulted in the development of one antibiotic terramycin which is used to treat many infections.

5. **Drugs from bacteria**

Many antibiotics are obtained from bacteria i.e. streptomycin etc.

Q.7 How drugs are classified? Describe the usage of important medicinal drugs?

OR Write any three medicinal drugs. Explain in detail. **(Board 2014)**

Ans. Drugs are classified on the basis of their chemical properties and modes of action.

1. **Analgesics**

(Pain killers)

Reduce pain e.g. aspirin, paracetamol etc.

2. **Antibiotics**

Inhibit or kill bacteria and treat bacterial infections e.g. tetracycline, cephalosporin etc.

3. **Sedatives**

Induce sedation by reducing irritability or excitement e.g. Diazepam.

4. **Vaccines**

Vaccines are used to develop immunity against viral and bacterial infections e.g. vaccines against small pox, whooping cough, hepatitis B etc.

5. **Antiseptics**

Reduce the possibility of infections on skin.

6. **Antibiotics**

Inhibit or kill bacteria within or on the body. Sir Alexander Fleming discovered the antibiotic penicillin from the fungus *penicillium notatum.*

7. **Disinfectants**

Destroys microorganisms found on non-living objects. Joseph Lister introduced carbolic acid to sterilize surgical instruments and to clean wounds.

Q8. Describe the things to remember while using the medicines.

Ans. Following things should keep in mind before using medicines:

(i) We should always check the instructions on doctor's prescription slip and take medicine accordingly.

(ii) Before using, we should check the expiry date because expired medicines may prove poisonous.

(iii) Never take medicines prescribed for someone else even if you think you have the same medical problem.

(iv) Antibiotics must be taken for a specific number of days. Otherwise problem may come again.
(v) We must consult with the doctor before we stop taking a medicine or consider a new treatment.
(vi) Some medicines are not suitable for children, and there are special children's dosages for many medicines.
(vii) Do not take medicine in the dark.
(viii) If you are patient, carry medicines and dosage instructions with you, whenever you are out of home.
(ix) Always keep healthcare products out of the reach of children
(x) Do not use the medicine if there are signs of tampering. Inform the pharmacist and manufacturer about it.

Q.9 Write a note on addictive Drugs. **(Board 2014)**

Ans. Major categories of addictive drugs are:

1. Sedatives

(a) Introduction

These drugs interact with central nervous system to depress its activities. Sedative drugs have following effects:

(b) Effects:

i. Induce dizziness
ii. Lethargy
iii. Slow brain function and depression
iv. Long term use of sedative induce suicidal thoughts

2. Narcotics

(a) Introduction

Narcotics are strong pain killers. These drugs are often prescribed in conjunction with other less potent pain killers (paracetamol or aspirin).

(b) Uses of Narcotics

i. These are used to relieve pain for patients with chronic diseases such as cancer.
ii. These are also used to relieve acute pain after operations.
iii. The abused narcotic i.e. heroin is a semi synthetic drug from morphine. It affects on central nervous system and causes drowsiness.
iv. Some people may abuse narcotics for ecstatic effects
v. Morphine and codeine are derived from poppy. Morphine is used to relieve pain.
vi. Heroin is prescribed as a strong analgesic under the name diamorphine in many western countries. It is used for acute pain such as in severe physical trauma, myocardial infarction, post surgical pain etc.



Figure 18.2 The Fruits of the opium poppy plant

3. Hallucinogens (Board 2014)

(a) Introduction

Hallucinogens are the drugs that cause changes in perception, thought, emotion and consciousness.

(b) Groups

It has two groups:

i. Mescaline

Which comes from a cactus.

ii. Psilocin

Which comes from a mushroom.

(c) Effects

Physiologically, hallucinogens affects on:

i. Sympathetic nervous system.
ii. Causing dilation of pupils.
iii. Constriction of some arteries.
iv. Rise in blood pressure.

3. Marijuana (Hashish)

(a) Introduction

Marijuana (Hashish) is a hallucinogen which is smoked. It is the Marijuana most commonly used drugs in the world.

(b) Sources:

It is obtained from the flowers, stems and leaves of the marijuana plant *(Cannabis sativa)* and *(C. indica).*

Effects

i. Small doses of marijuana result in a feeling of well-being that lasts two to three hours.
ii. High doses increases heart rate.
iii. It affects the production of sperms in men.
iv. It weakens the short term memory.

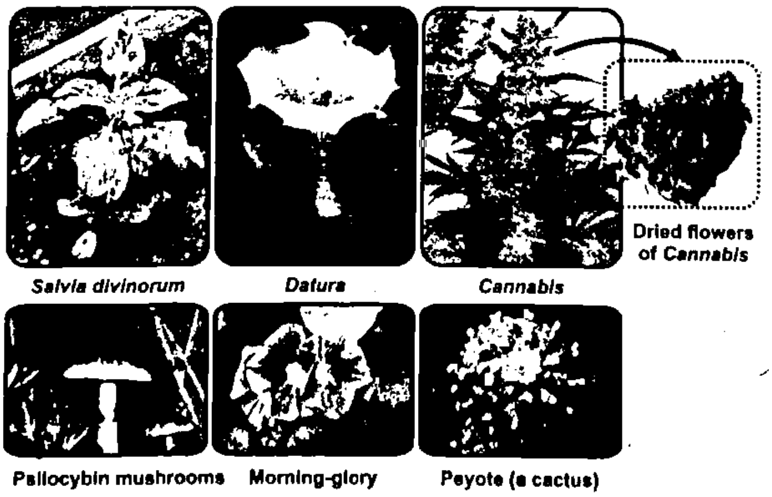


Figure 18.3: Plants from where hallucinogens are obtained

Q.10 What is drug addiction? Discuss its associated problems?

Ans. Drugs addiction

Some drugs often make person dependent on them or addicted. By using such drugs, the person's body become familiar to it and the user cannot function well without it. This is called drug addiction.

Drug addiction and associated problems

Drug abusers go through withdrawal of social contact or communication. Many studies by the experts of social sciences prove that there exists a close relationship between drug addiction and crime.

Problems of drug addiction

1. Law violation

The compulsion for narcotic drugs makes every drug addict a law violator and criminal. Mere possession of a narcotic drug is a violation of the law. Thus, every drug addict is subjected to arrest by the police.



The jails and prisons of our country are full of such people who have committed no other crime than the illegal possession of narcotics.

2. Involvement in Crimes

Most drug addicts get involved in various crimes e.g. Robbery, shoplifting, burglary, embezzlement etc.

3. Psychic patients

Drug addicts may commit violent crimes since so many become psychic patients.

4. Weak social behaviour

The addicts are very weak in their social behaviour. They face social stigma. i.e. the society dislikes them because of their unpredictable behaviours.

Q.11 What are antibiotics? How do they work? OR Discuss their uses.

Ans.

Antibiotics

An antibiotic is a drug that kills or retards the growth of bacteria. They are the chemicals produced by or derived by microorganisms (bacteria and fungi).

Bactericidal Antibiotics

Antibiotics are used to treat many different bacterial infections. Some antibiotics are "bactericidal", meaning that they kill bacteria.

Bacteriostatic Antibiotics

Antibiotics are those which work by stopping bacterial growth.

Broad-spectrum Antibiotics

Some antibiotics can be used to treat a wide range of infections and are known as broad-spectrum antibiotics.

Narrow-spectrum Antibiotics

Others are only effective against a few type of bacteria and are called narrow spectrum antibiotics.

Q.12 Describe the main groups of antibiotics?

Ans. Three major groups of antibiotics are described below:

1. Cephalosporins

Caphalosporins interfere with synthesis of bacterial cell wall and so are bactericidal. They are used to treat pneumonia, sore throat, tonsillitis, bronchitis etc.

2. Tetracyclines

These are broad spectrum bacteriostatic antibiotics and inhibit bacterial protein synthesis. Tetracyclines are used in the treatment of infections of respiratory tract, urinary tract, intestine etc.

Precaution

These are not used in children under age of 8, and during period of tooth development.

3. Sulpha Drugs-Sulfonamides

Sulpha drugs are synthetic antibiotics that contain sulfonamide group. These are broad spectrum bacteriostatic antibiotics.

Uses

They are used to inhibit folic acid synthesis in bacteria. They are used to treat pneumonia and urinary tract infections.

Q.13 Describe the antibiotic resistance?

Ans.

Antibiotic resistance

Antibiotics are most important in medicine but unfortunately bacteria are capable of developing resistance to them. Such bacteria are not affected by commonly used antibiotics, this condition is called antibiotic resistance.

Ways of resistance

Bacteria have number of ways of developing resistance.

i. Stopage by internal mechanism

Sometimes, their internal mechanism stops the working of antibiotics.

ii. Gene transfer

Bacteria can also transfer the genes responsible for antibiotic resistance between them. Such bacteria make it possible for other bacteria to acquire resistance.

iii. Efficacy

Another cause of antibiotic resistance is their use in diseases in which they have no efficacy (e.g. antibiotics are not effective against infections caused by viruses).

Problems Related to Resistance to antibiotics

1. Some bacterial infections are becoming more difficult to treat,
2. Some of the resistant bacteria can be treated with more powerful antibiotics.
3. Some infections do not eliminate even with new antibiotics.

Q.14 What are vaccines? Who introduced world's first vaccination?

Ans. Definition: **(Board 2014)**

A vaccine is a material containing weakened or killed pathogens and is used to produce immunity to a disease by stimulating the production of antibodies.

World's First vaccination

In 1796, a British physician, Edward Jenner, infected a young boy with cowpox, by injecting pus cells. After the boy had recovered from cowpox, Jenner injected the pus cells from a smallpox patient into him. The boy did not get smallpox.

So it became clear that intentional infection with cowpox protected people from small pox. This method was named vaccination and the substance used to vaccinate is called a "vaccine".



A painting showing Edward Jenner, injecting the boy, it was the world's first vaccination.

Q.15 Describe the mode of action of vaccines?

Ans. Antigens

Pathogens contain special proteins called antigens.

Antibodies

When pathogens enter the body (blood) of host, these proteins stimulate the immune response in host i.e. synthesis of antibodies. Antibodies bind to pathogens and destroy them.

Memory cells

These cells are produced which remain in blood and provide protection against future infections with the same pathogen.

Action of vaccine / Working of Vaccine **(Board 2014)**

When a vaccine i.e. weakened or dead pathogen is introduced into bloodstream, the white blood cells are stimulated; B-Lymphocytes recognize the weakened or dead pathogens as enemies and start producing antibodies against them. These antibiotics remain in blood and provide protection against pathogens. If real pathogens enter blood, the already present antibodies kill them.

Q.16 When and why children are vaccinated?

Ans. Children are required to be vaccinated before attending school. The vaccination of children has resulted in marked decrease of common diseases i.e., whooping cough, polio, small pox and others. Some vaccines do not provide life time immunity.